A Distributedsensor-Cloud Approach To Detect and Energy-Efficient Re-Connectivity of Dumb Nodes In Homogenous Wireless Sensor Network

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Abstract- In today's world, a huge number of tiny sensor embedded application devices increases day by day.A network that contains a large amount of sensors that can be used to sense data over the worldwide without any user interaction is called wireless sensor network(WSN).In recent years, with the development and ongoing technology, wireless sensors are mainlyused to monitorhealthcare organizations,temperature,humidity,forest fire, Medicine,Sports,environment control,home automation appliances and in many more daily uses applications. WSN is anindependent and self-organized network. In concerned to energy-efficiencyis the most important attribute to enlarged the network lifetime and Performance. The nodes that have the efficiency to sense data, but can'ttransmit data further such type behavior called dumb nodes(DN). The isolated node can't communicate to its neighbor node due to environment effects and shrinkage in the communication range. Therefore, a proposed technique called SCA(sensor-cloud approach) to detect whether a node behaves as a dumb or not and, re-connects it with the network when the environmental conditionsbecome normal. In this paper, we find the proposed scheme that shows re-connectivity with the network and also increase the networkperformance in the existence of the dumb nodes.

Keywords: Wireless sensor network(WSN), Dumb Node(DN), environmental effects,single-hop,cloud

Introduction

Advancements of wireless sensors in technology lead to development in wireless sensor technologywhich containsawide range of less-cost,high-performance wireless sensors.Today, wireless sensors are mainly used for each and every application[1,2]. A WSN is a self-organized network havinglimited transmission and communication range.The transmissionhas performed to a network over single–hop[3,4]or multi-hop connectivity[5,21].so,it should be essential for active participation for data transmission and communication with the sink node within the network. The cloud computing has the potential feature to collect a large amount of processed data.However, a sink node collects all the sensor data and sends it to the cloud server. Therefore,it is important for the existence ofactivenodes, so that the connectivity which haslost can be re-established.Environmental effects are temporaryand dynamic in concern of time. Thus, it gets isolationwhich decreased its required communication range,and such kind of behaviornode is called a dumb node[6].Dumb behavior created a problematicenvironment that spreadsmischievous effects of the operation of sensed data. Therefore, it is very important how to identify, detect the dumb nodes and how to increase the energy efficiency of the network in an adverse environment.

1.1. Motivation

In the wireless sensor network, the presence of the dumb node leads to the destructive effects of theoperations of the networks. So, it is challengeable to explore the dumb nodes which have lost the communication operation of the network. The dumb nodes can sense data in the adverse of surrounding conditions,but not able to further transmit.Since the environmental effect is non-permanent,so as its behavior is dynamic and temporal the dumb nodes start to communicate and perform normal operations when the obstacles break down.

In consequence, the connectivity of the dumb node is necessary with the sink node so that corrected data can be store to the cloud server. So, a approach is required which can detect all such nodes.Thus,to identify the existence ofsuch type of node makes a challenge.Therefore, it is important to identify and explore the dumb node and establish the re-connectivity between the intermediate nodes causing the energy consumption which enhances the network performance.

In this work, the proposedapproach identify, detect, and makes the communication rangebetweendumb users and the sink node. The sink node collects all sensed data and stores it into the cloud server. The environmental conditionslike rainfall,fogaffect the node which makes the nodea dumb node .when the node isolated from the network it can't communicate with other nodes. and when such type of effects resumed, the nodes performs normal operationsand can easily re-connectivity with the sink node by the consumption of efficient energy. The contributions are followed as:

(i) We propose an approach for the detection of all these in WSN using the SCA.

(ii) We analyze the detection problem in adverse effect within the different time interval

(iii)We enhance the energy efficiency approach tomake connectivityintiallyactive nodes
with the sink node.

The paper is organized in various sections.Section 2 defines the related work.The problem descriptionexplained in section 3. The proposed scheme described in Section 4. Section 5 provides simulation design and performance results. Finally, we conclude the work in Section 6.

2. Related work

Most of the research work has been proposedand many approaches have to be done, to detect andestablish the re-connectivity for dumb nodes. P.kar [7] defined dumb node by taking a static network with many assumptions and it described its behavioris non-permanent due to temporal environment effect. Roy [11] define the behavior of a dumb nodethat doesn't exist permanently but its prolong affect the network behavior. By using a distributed approach the dumb nodes can reconnect with the intermediate node,but he didn't discuss the energy performance of the network. Sahani et al. [12] proposed optimized ant colony algorithm which uses artificial to communicate with their neighbor ants but they considered many assumptions for the wireless sensor network.They also concentrate on the energy consumption using by ant for a long time. Suhonen et al. [13]describeda routing protocolbased on a multi-hop protocol for wireless sensor networks and also compare single-hop protocols with multiple-hop protocols. In the protocol, they use metrics to create a source to the destination node. The metrics [19,20] tracksthe connectivity information of sensor nodes,load delay [14] thatalso describe the fault tolerance and energy consumption.Kadri et al.[16] described various theoretical techniques to increase energy efficiency as per the request requirement ofrouting requests [17,18].The proposed approach identifythe sleep or dumb nodes in adverse effect and using cloud services to increase network performance by re-establishment the connectivity.

3. Problem description

In a wireless sensor network,all such type of behavior nodes that can sense data in an adverse environmental conditions, but due to onset of the sudden environmental affects on sensor range and as a result, they can't communicate with its closest node. Thus, in results, a nodebecomes isolated from the network. So, an active nodes are required which can make a suitable range between them which increases operations efficiency for the network. The reestablishmenttechnique needed to make connections of an intermediate with a sink node which further transfer data to the cloud server . Therefore, it isimportant to identify the existence of dumb node. The non-permanent nature of dumb behavior makesit asa major issue. This work helps to find the solution in a wireless network and reestablishment with the sink node using SCA in WSN.

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System Architecture

3.1. Network Approach. We deployed homogeneous sensor nodes in which every node having similar sensing and transmission characteristics within a static network within interested region. All such nodes consist GPSfeatures and scattered at different positions withina certain region. Cloud CSP provides the infrastructure maintenance facility to each user. We consider various environmental effects like rainfall,fog which probably annoyed the transmission operation.

3.2 NormalBehavior (NB): The node which can collect data from a network,and can communicate further along its wholeduration with the network is defined as NB.It Is mathematicallyrepresented as :

$$\mu_d = \begin{cases} 1 & 0 < dbmin \leq r(t_i) \leq CR),\ \forall t_i \\ 0 & \text{Otherwise} \end{cases}$$

where CR - Specified communication range
μ_n -- Normal behavior
N- No. of sensor nodes
μ_d - Dumb behavior
dbmin - Distance from a node to its closest node
N_A- no. of active nodes
r(t)- Communication range at time t

3.3Dumb node..This approachdetect a node that can sense data but can't perform its operation further at an instant of timebecause its communication range shrinks.It is denoted by μ_d and mathematically defined as:

$$\mu_d = \begin{cases} 1, & 0 < dbmin \leq r(ti) \leq CR)\} \ \&\& \ \{0 \leq r(tj) < dbmin < CR,\ \forall t_i, \forall t_j,\ ti \neq tj \\ 0 & \text{otherwise} \end{cases}$$

The range of communication for a node is represented by CR at any time instant t_i, i.e. written as $CR(t_i.)$ After the existence of the adverse environmental effects at anytj ,and represented as $CR(t_j)$, such that $CR(t_j) < dbmin$.When $CR(t_j) < dbmin$ the node is unable to communicate with any other intermediate or sink node. As a result, it becomes dumb.

4. Proposed Approach

Sensor-Cloud Approach(SCA)

In this approach, the cloud facilities are provided to the users by giving various services from wireless sensor network We assume a large region is deployed with a large number of sensors having homogenous characteristics. All sensor having a GPS feature.The sensor nodes transmit its datato the sink and itfurther responsible its collected data to the cloud server. The Cloud Knows the positions of all the sensor nodes. Among all, some node behavior is dumb and can't able to communicate the sensed-data to the neighbor node due to unfavorable environmental conditions and few nodes activated to communicate within the respective region. Therefore, the cloud plays an important role to analyze the sensed data. In the proposed approach, the cloud works as a decider and detect the dumb nodes.It also decidesand calculate total dumb nodes that is able to establisha link through the cloud service.The followers in CD_N gives the degree of dumb nodes.

Here N - represents total no. of sensor nodes
N_d - calculate the total dumb nodes, $N_d \in N$
The duration length of the network is defined as the max sensor node distributed over the region is denoted as:
$L = \text{argmax}\{L_1, L_2, L_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots L_n\}$
L_N- total duration of the network
L_n – duration of the sensor node $\forall\ n \in N$

$CD_N$is defined as:

$CD_N = \{ C^p . C^D . N. N'.\text{cloud}. \Omega(.)\}$

C^p - No. of nodes present in network due to environment effects

C^D - calculated DN's

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N - No. of activation in the network

N’ - Total No. of activated nodes

cloud. $\Omega(.)$ cloud decider & utility function in the network & it is calculated as:
$\Omega(.)= R(.)- \mu(.)$ where $R(.)$—Revenue function $\mu(.)$ — Cost function

$R(.)= \phi (C^D / C^p)$ & $\mu(.)= \phi (N / N')$

Based on utility function $\Omega(.)$ cloud makes the lifetime of the sensor network to enhance the quality of service and performance of the network with different time intervals in the region.This helps the cloud to decide whether a node is dumb or not and based on active sensor node it establish the re-connectivity based on the calculatedactive node.Re-connectivity will successfully increase the performance by applying the proposed approach.

5. Performance Evaluation

a) System design

In the experiment design, the performance is shown for the detection of non-active nodes by using the proposed approach. For the experimental setup, various parameters are used and depicted in table 1. Homogenous sensors are deployed at different positions over within the region and each sensor is GPS enabled.From the entire monitored region,the sensor data transmit to the cloud server.The entire infrastructure is controlled by the CSP.

Table 1.

No. of Nodes(N)	50-350
Simulated Area	500mx500m
Sensor Range	30m
Communication Range	40-60m
Data transmit Speed	250Kbps

The results are performed by evaluating the parameters for the proposed approach as follows:

a) Dumb nodes (DN)(in %)- It defines the number of nodes that exist per 100 nodes.
b) Detection of DN(in %)- It defines the number of detected nodes that exist per 100 nodes.
c) Energy consumption – It represents the energy consumption required to detect and re-establish the link between them with the sink.

Results

Figure 1. shows the existence of dumb nodes at different time intervals.It indicates when the CR decreased, the no. of DN (in %) increased within different time intervals.The Range shown onthe X-axis and no. of dumb nodes(in %) on Y-axis.

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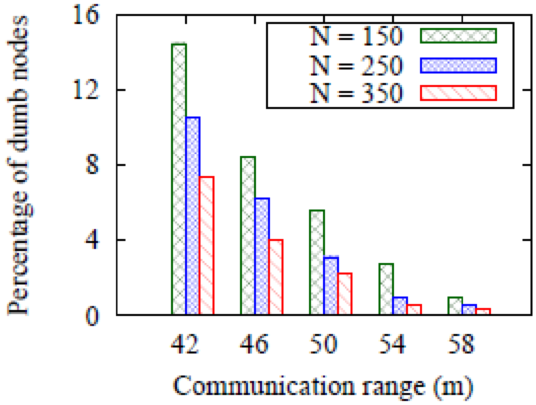
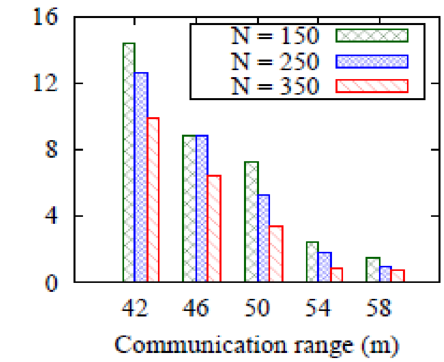


Percentage of dumb nodes present in the network

Fig 1.



Percentage of newly activated nodes

Fig 2.

Figure 2. depicts that increase the dumb nodes in a wireless network also increase the no. of activated nodes. The different results shown by taking different no. of nodes.

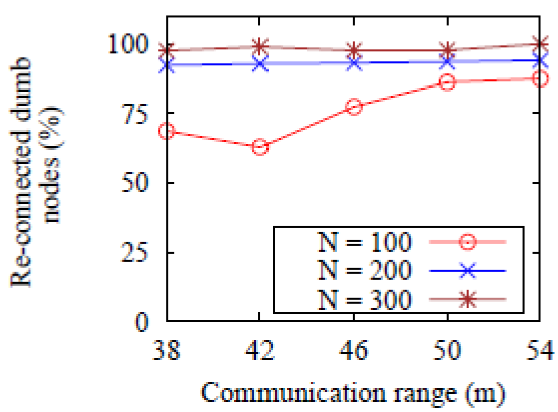
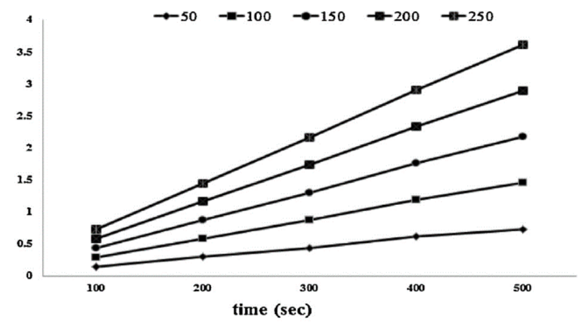


Fig 3.



Energy Consumption for different dumb nodes

Fig 4.

Figure 3. described the number of DN(in %) reconnected with the sink node and figure 4 represents the energy consumption for different dumb nodeswhen they re-connect with the sink node. We observe that by applying the proposed approach increased the network performance.

6. Conclusion

In WSN, the dumb node can't communicate with the neighbor node but only can sense data. Its existing dumb behavior due to shrinkage of communication range in the adverse environmental conditions leads to the node becomes isolated, which decrease the network performance.The proposed approach, SCA that established re-connectivity of isolated nodes to sink and also analyze sensed data based on cloud service. The cloud detector itself detects the position of the sensor node through GPS and provide the facility to the followers to communicate with the sink when the unfavorable conditions resumed. In the future, the work will reduce the energy consumption for different dumb nodes.

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