International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 1 (2018) pp. 233-237

Energy Efficient Routing Strategy for Automated Irrigation

Ashwini.S
Research Scholar, Department of Computer Science,
Christ University, Hosur Road, Bhavani Nagar, Bengaluru, India.
Orcid: 0000-0002-5427-0538

Deepa.V. Jose
Associate Professor, Department of Computer Science,
Christ University,Hosur Road, Bhavani Nagar, Bengaluru, India.

Abstract

Wireless Sensor Networks need to be energy efficient as they are resource-constrained in nature. In this paper an approach to increase the energy efficiency through routing is proposed taking into consideration the agriculture domain. An overview of various energy efficient routing protocols in Wireless sensor networks for agriculture domain is also presented. The proposed energy efficient routing approach is compared with the LEACH (Low Energy Adaptive Clustering Hierarchy) protocol based on energy efficiency in different scenarios. The improvement in energy efficiency achieved through modification of the existing LEACH protocol is also presented.

Keywords: Wireless sensor network, energy efficiency, routing, agriculture, clustering

INTRODUCTION

Wireless sensor networks (WSN) contains large amount of sensor nodes which are distributed across the network and later interrelated among each other through wireless media, It is vital to elongate the network connectivity. The task of these sensor nodes is to send the sensed data to the designated sink called the base station (BS). The BS is the final point of connection to get the information. In this era, usage of WSN spreads across various domains such as agriculture, habitat monitoring, target location tracking, automating home systems, rescue operations, constant surveillance, stock monitoring, biomedical applications, industrial applications and many more. In the area of WSNs, major research is carried out to cut down the energy consumption with the help of efficient routing protocols so as to retain the connectivity of the network to the maximum extent possible.

Majority of the energy efficient routing techniques use the concept of clustering to minimize the energy usage and improve the overall network lifetime. In clustering technique [5] all the sensor nodes will not participate in data transmission instead the cluster head will be responsible for the data transmission. This reduces the energy usage of the sensor nodes. But this can lead to hot spot issues as the cluster heads will continuously participate in data transmission and dies off fast; especially those near the BS[6]. Uneven clustering is introduced in the proposed work to avoid this issue. The rest of this paper is organized as follows; initially an insight to the various existing literature based on routing protocols used in agriculture domain is given followed by the proposed methodology. Lastly, simulation results followed by conclusions and future scope is given.

LITERATURE REVIEW

Al-Karaki and Kamal [1] have given a detailed survey of the different routing techniques in WSNs where all the protocols developed till 2004 is explained in detail with their advantages, drawbacks and their future scope. Pantazis et al. [2] gave a detailed survey of the WSN routing protocols till 2014. These two papers describe the different routing strategies in WSNs. According to them is given to the mobility of the sensor nodes or sinks which occur in WSNs.

The concept of clustering, and LEACH protocol, was suggested by Heinzelman et al.[4]. Even though LEACH is energy efficient, it has many drawbacks mainly related to clustering and selection of cluster heads. An overview of the various applications of WSNs in agriculture sector mentions the advantage and disadvantage as in Table.1.

Table 1: Overview of the various applications of WSNs in agriculture sector [6-15].

Sl.No	Title, Author, Year	Methodology	Advantages
1.	Automatic irrigation system for agriculture field using WSN. Rashmi Jain et.al. Apr-2016	The values of sensors are monitored through MATLAB Application	A Topology structure is used to make each and every node communicates with each other.
2.	Evaluation.of routing protocols used in WSN monitoring temperature in composting heap Velavarthy neehaarika et al	By using NS2 comparison is made of different routing protocols and a new protocol is being proposed	Survey of performance of AODV, DSDV, DSRO using 85 sensor nodes
3.	Path determination algorithm of mobile sinks. for energy efficient data collection and optimal coverage in WSN. Nimisha Ghosh et al. 2014	An efficient algorithm has been proposed.	Energy saving in terms of delay
4.	An energy efficient routing protocol with controllable expect delay in duty-cycled WSN JieHao et al 2013	Uses Markov decision process based routing for forwarding the packets	Delay in routing is less.
5.	ARM based wireless sensor networks for temperature measurements. U.Sarojini Devi, R,Malikarjun 2013	Software design of Data acquisition is achieved here. The programs of Wi-Fi drivers and SD Cards and are programmed based on open source LinuxOS.	Broader coverage higher transmission rate , uses SD card for serial, data transmission(max of 100 mbps)
6.	Analyzing Energy efficiently and route selection of multilevel hierarchical routing protocols in WSN. M.S Fareed et al 2012	Clustering approach has been followed which has been implemented in MATLAB.	Energy conservation of sensor in different scenarios.
7.	Optimized energy efficient routing protocol for life time improvement in WSN K Kishanchand et al 2012	Protocol Performance using NS2.	The suggested protocol gives better results when compared to LEACH and as well as the energy is saved
8.	A survey of WSN architecture. Almir Davis, Hwa chang 2012	Survey is performed on various WSN architecture.	Comparison of several architecture methods.
9.	Simulation and performance study of WSN using Matlab. Qutaiba Ibrahem Ali et al 2011	A new simulation of WSN using MATLAB Simulink is been implemented.	Simulink MATLAB is flexible in the study of various physical layer parameters.
10.	A Crop Monitoring System Based on Wireless Sensor Network Zhao Liqiang et.al 2011	The aim of this distribution protocol is to send a piece of control and synchronization instructions reliably to each node in the network by using TinyOS (IOT) for agriculture	Useful for applications in the field of precision agriculture.
11.	Delay bounded and robust routing protocol For emergency applications using wireless sensor networks Yuangyan et al 2010	The simulations of routing is Implemented and verified using the NS.	It is designed for Emergency applications. Achieved excellent real time delivery of packets in hazardous simulation.

Proposed Energy Efficient Method

The enhancement of the LEACH protocol was developed by modifying the clustering process and keeping the rest of the phases as that of the LEACH protocol. Here uneven clustering is introduced so as to avoid uniform cluster sizes. The network model and simulation parameters adopted by LEACH were used for simulation of the proposed enhanced LEACH. The simulation is implemented using MATLAB by changing the parameters to establish the efficiency of the suggested approach. A simple first order radio model [4] has been assumed where energy per bit over transmission is given by

$$e_{tx}(d) = e_t + e_d \times d^n \quad (1)$$

Where e_t is the dissipated energy per bit in the transmitting circuitry and $e_d \times d^n$ is the dissipated energy for transmission over a distance 'd', 'n' being the path loss exponent.

For a first order model, (Usually $2.0 \leq n \leq 4.0$) we assume n=2 for the simulation and the total energy being dissipated for the transmission of a K-bit packet is given by

$$E_{tx}(K, d) = (e_t + e_d \times d^2) \times K \quad (2)$$

If e_r is the energy required per bit for a successful response, then the dissipated energy for receiving a K-bit packet is

$$E_{rx}(K) = e_r \times K \quad (3)$$

For simulations, e_t = 50 nJ /bit, e_d = 100 pJ/bit/m^2 and $e_r = e_t$.

Considering that the channel is symmetric, in a way that the energy spent on relaying from the node i to j is similar to that of relaying from node j to i.

The following assumptions are made during the simulation:

- N sensor nodes are arbitrarily scattered within a sensing field A.
- A Base Station (BS) is deployed at the left corner of the deployed area.
- All the nodes and Base Station (BS) is fixed after being deployed. The position of BS is known to every individual node.
- Depending on the distance from the receiver, the sensor node uses their power control to differ the amount of power that is transmitted from them. For the sake of ease, it is considered that the level of power is uninterrupted. The sensing process is also assumed to be continuous.
- Communication between the nodes is symmetric and the sensors can calculate the distance approximately on the based on the strength of the received signal that is provided the transmission power.
- All the sensor nodes are homogeneous, i.e., they have the same capacities and same initial energy level and are non-chargeable.

The proposed method is described below. [BS is assigned as the Base Station, RSS is the received signal's strength, CH is assigned as the cluster head node, N= deployed nodes, A is the deployed area, maxCount=5% of deployed nodes, t is the time limit and R range of the sensor which is dependent on the application].

- At the beginning, all the sensor nodes pass their respective information to the BS along with their immediate neighbors.
- Every node retains a count value along with a maxCount value.
- In time 't' every node finds its associated neighbors in the sensor range.
- Select node that has the count equal to maxCount in the stipulated time as the Cluster head, it sends its messages to its nearby (immediate) neighbors to authorize itself as the cluster head.
- On the basis of the strength of the received signal every node passes back the information content to its appropriate cluster head and forms clusters using this information as a base.
- The cluster heads provides the TDMA schedule to every node that they can relay the data that is sensed to their respective heads.
- The cluster heads maintain necessary data about the remaining power of all its nodes and their corresponding distance to the base station.
- Data accumulated by the members of the clusters will be sent forward to the base station also called the Sink node by their respective cluster heads.

Simulation Results

The number of live nodes over a period of time for different scenarios, by modifying the number of sensor nodes and the area of simulation were performed using MATLAB based on the parameters of simulation as shown in Table 2.

Table 2: Simulation Parameters

Parameters	Values
Number of sensor nodes	100
Area of simulation	100m×100 m
Range of sensor nodes	20 m
Number of static sink	1
Initial energy of sensors	50 J
Transmission energy	0.5 J
Receiving energy	0.2 J

Trials were carried out for different cases where the area of deployment, number of nodes and the simulation time were repeatedly changed. Figure.3 portrays the performance analysis of the algorithm that is proposed with the protocol LEACH based on number of alive nodes over the simulation period of 50s. It is clear that the proposed protocol provides an improved life time in collation to the standard LEACH protocol since the number of alive nodes are higher for the suggested one all through the testing period. Number of live nodes at different pause times 10s, 20s, 30s, 40s and 50s are represented in Figure 1.

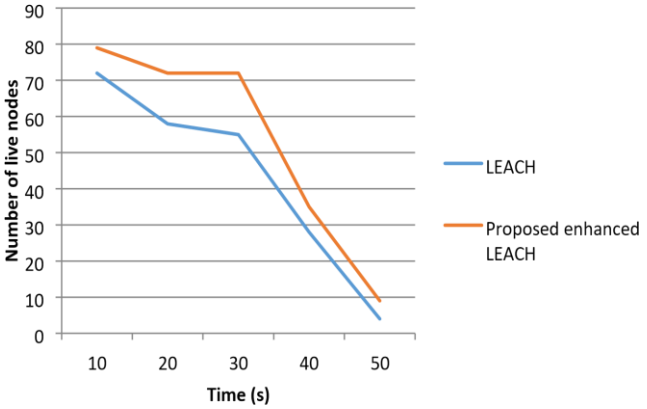

Figure 1: Comparison of number of live nodes over a period of time (N=100, A=100)

For collecting the real time data, the setup used is given in Figure 2 and Figure 3. The system is expected to fulfil the needs of farmers in order to help them in making their work easy. The system automates the work of watering the field by making the irrigation system more feasible. Soil moisture sensors were inserted in the soil which will read the water content of the same. The data received from the sensors are

given to the Arduino as input for taking a decision. Arduino sends a message to the phone indicating the level of water content. This is being acquired with the help of GSM technology. Sample output values are given in Table 3. The user receives the message and controls the operation of the motor which is used to activate the pump that waters the area.

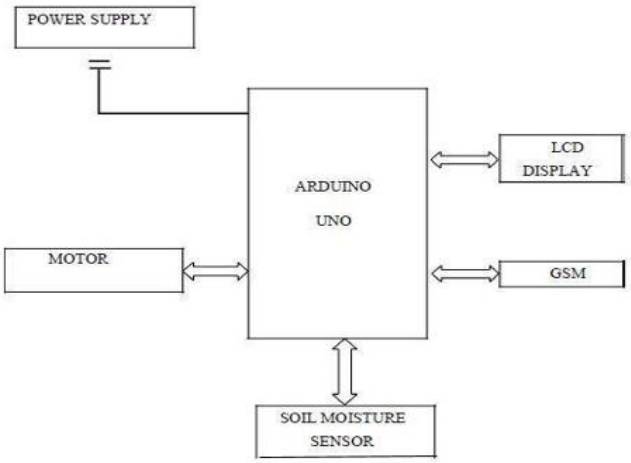

Figure 2: System Architecture

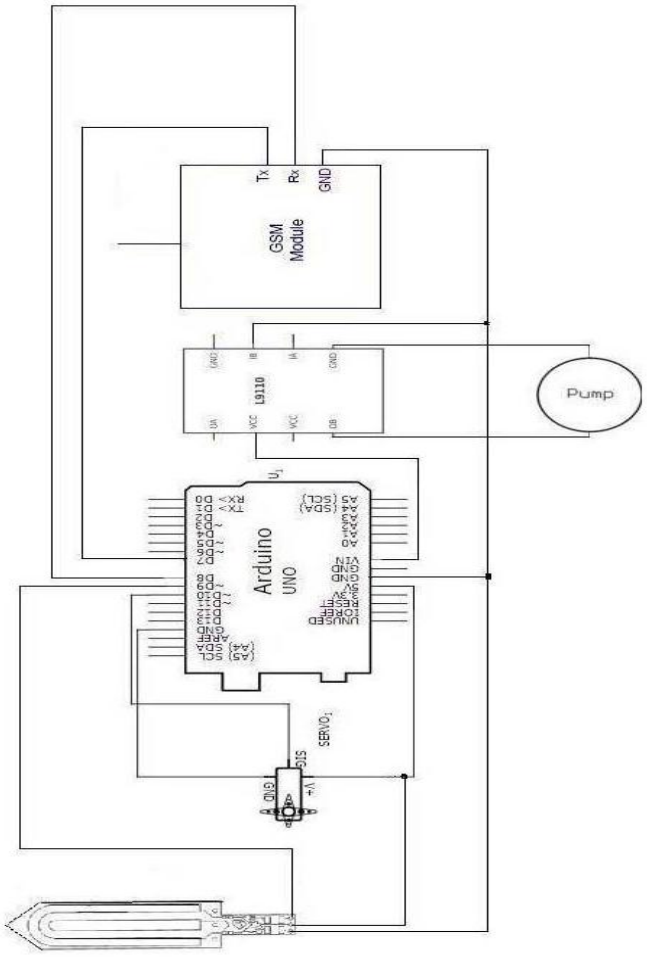

Figure 3: Hardware Circuit Diagram

Table 3: Output Values

Item	Condition	Min	Typical	Max	Unit
Voltage	-	3.3	/	5	V
Current	-	-	/	35	mA
Output Value	Sensor in dry soil	-	-	300	/
	Sensor in humid soil	300	-	700	/
	Sensor in water	700	-	950	/

Conclusion and Future Scope

In this paper an energy efficient routing approach using uneven clustering is proposed for the agriculture domain. The results obtained prove that the proposed method is much more energy efficient than LEACH. The data collected in real-time from our agricultural setup proved the improved efficiency of our protocol. The future work will be to compare the proposed approach with latest variations of LEACH protocol and to test it in on a large-scale network to observe the performance.

REFERENCES

[1] J.N. Al-Karaki and A.E.Kamal, "Routing Techniques in Wireless Sensor Networks: A survey," *Wireless Communications, IEEE*, vol.11, no.6, pp.6, 2004.

[2] N. A. Pantazis, S. A. Nikolidakis and D. Vergados,"Energy-Efficient Routing Protocols in Wireless Sensor Networks: A Survey,"*Communications Surveys & Tutorials, IEEE*, vol. 15, no. 2, pp. 551, 2013.

[3] S.A Nikolidakis, D. Kandris , D. Vergados and C. Douligeris, "Energy Efficient Routing in Wireless Sensor Networks Through Balanced Clustering," *Algorithms*, *6*, pp.29,2013.

[4] Wendi RabinerHeinzelman, AnanthaChandrakasan, and Hari Balakrishnan, "Energy-Efficient Communication Protocol forWireless Micro sensor Networks," in *Proceedings of the 33rd Hawaii International Conference on System Sciences – 2000*,pp.1, 2000.

[5] Dali Wei, YichaoJin, SerdarVural, Klaus Moessner and Rahim Tafazolli, " An Energy-Efficient Clustering Solution for Wireless Sensor Networks, ", *IEEE Transactions on Wireless Communications*,Vol.10,no.11,2011.

[6] V. Neehaarika, S. Sindhura, "Evaluation of routing protocols used in wireless sensor networks monitoring temperature in composting heaps", *India Conference (INDICON) 2011 Annual IEEE*, pp. 14, Dec 2011.

[7] N. Ghosh and I. Banerjee, "An energy-efficient path determination strategy for mobile data collectors in wireless sensor network," *Comput. Electr. Eng.*, vol. 48, no. October, pp. 417–435, 2015.

[8] J. Hao and K. Huang, "An Energy-Efficient Routing Protocol with Controllable Expected Delay in DutyCycled Wireless Sensor Networks," no. 2012, pp. 6215–6219, 2013.

[9] U. S. Devi, R. Malikarjun, I. I. Year, and M. T. Es, "ARM Based Wireless Sensor Networks for Temperature Measurement," vol. 1, no. 1, pp. 1–4, 2013.

[10] Fareed, M.S.; Javaid, N.; Ahmed, S.; Rehman, S.; Qasim, U.; Khan, Z.A., "Analyzing EnergyEfficiency and Route-Selection of Multi-level Hierarchal Routing Protocols in WSNs", Broadband, Wireless Computing, Communication and Applications (BWCCA), 2012 Seventh International Conference on, Vol., no., pp.626,631, 12-14 Nov. 2012.

[11] K. KishanChandl, P VijayaBharati and B. Seetha Ramanjaneyulu, Member, IEEE, "Optimized Energy Efficient Routing Protocol for Life-Time Improvement in Wireless Sensor Networks", IEEEInternational Conference On Advances In Engineering, Science And Management (ICAESM 2012) March 30, 31, 2012.

[12] Almir Davis, Hwa Chang (December 2012), "A Survey of Wireless Sensor Network Architectures", Department of Electrical and Computer Engineering, Tufts University, Medford, USA, International Journal of Computer Science & Engineering Survey (IJCSES) Vol.3, No.6.

[13] Qutaiba I. Ali, Vasilios Katsikis, "Simulation Framework of Wireless Sensor Network (WSN) Using MATLAB/SIMULINK Software" in MATLAB - A Fundamental Tool for Scientific Computing and Engineering Applications, InTech, vol. 2, 2012.

[14] Z. Liqiang, Y. Shouyi, L. Leibo, Z. Zhen, and W. Shaojun., "A Crop Monitoring System Based on Wireless Sensor Network," *Procedia Environ. Sci.*, vol. 11, pp. 558–565, 2011.

[15] Y. Zeng and G. Zheng, "Delay-bounded and Robust Routing Protocol for Emergency Applications Using Wireless Sensor Networks," no. 2, pp. 2–6,2010.