International Journal of Computing Science and Information Technology, **2018,**
ISSN: 2278-9669, April 2018 (http://ijcsit.org)

Optimizing Energy and Data Storage in WSN integrated Cloud applying Fuzzy method.

Suma S.V

Assistant Professor, Department of Computer Application

Presidency College, Bangalore

Email: sumasv2009@gmail.com

Abstract

WSN integrated cloud is the latest innovation connected all sensors devices to services provided at cloud computing servers. Many applications like tsunami monitoring, wild life monitoring etc are developed using this model. With the scalable resources provided at cloud, the service provider can scale his resource needs based on the business dynamics. Wireless sensor devices are energy constrained in many un attended environment and maintaining the life time of the sensor is important for the continuous operation of the network. Sensors fail due to frequent transmission and reception. Also storage at cloud is not infinite and as storage increases, the cost has to be taken care by the service provider. In this paper we provide a solution to optimize the energy at WSN and storage at cloud applying Fuzzy logic.

Keywords: Deviation from Neighbourhood (DVN), Wireless Sensor Network, Data Query.

1. Introduction

The Internet of Things (IoTs) can be described as connecting everyday objects like smart-phones, Internet TVs, sensors and actuators to the World Wide Web where the devices are intelligently linked together enabling new forms of communication between things and people, and between things themselves. Building IoTs has advanced significantly in the last couple of years since it has added a new dimension to the world of information and communication technologies. In 2008, the number of connected devices surpassed connected people and it has been estimated by Cisco that by 2020 there will be 50 billion connected devices which is seven times the world population. Now anyone, from anytime and anywhere can have connectivity for anything and it is expected that these connections will extend and create an entirely advanced dynamic network of IoTs. The development of the Internet of Things will revolutionize a number of sectors, from wireless sensors to nanotechnology.

One of the most important elements in the Internet of Things paradigm is wireless sensor networks (WSNs). WSNs consist of smart sensing nodes with embedded CPUs, low power radios and sensors which are used to monitor environmental conditions such as temperature, pressure, humidity, vibration and energy consumption.

Cloud computing is a flexible, powerful and cost-effective framework in providing real-time data to users at any time with vast coverage and quality. The Cloud consists of hardware, networks, services, storage, and interfaces that enable the delivery of computing as a service. In addition, it's also possible to upload the data obtained from the wireless sensor nodes to the Web services based on Simple Object Access Protocol (SOAP) and Representational State Transfer (REST), using messaging mechanisms such as emails and SMS or social networks and blogs. By connecting, evaluating and linking these sensor networks, data conclusions can be made in realtime, trends can be predicted and hazardous situations can be avoided.

Following challenges exist in WSN integration to cloud.

1. Due to continuous data collection from sensors, the energy at sensors is reduced and at some point the sensors fail and network life time ends.
2. Also due to continuous operation, storage at cloud increases.

This work is aimed at solving this two challenges applying Fuzzy logic to optimize the usage of energy in WSN and storage at cloud.

I. Related Work

In this section we survey the solutions for energy and storage management for WSN integrated clouds.

The energy-efficient techniques for the sensor cloud can be classified to six categories scheduling techniques, sensing techniques, data transmission techniques, advanced system designing, data processing, and load balancing techniques.

Scheduling Techniques

Energy-efficient and delay-aware computing system (E2DAWCS) is used to reduce the consumption of power by controlling both network connectivity and sleep scheduling within admissible delay [1]. Data aggregation, physical sensor scheduling, and low-power listening techniques are used to minimize the sending of sensed packets for transmission. As a result, energy consumption is further minimized [2]. Time division multiple accesses- (TDMA-) based scheduling for fine granularity tasks is used for energy saving, providing less response time and high throughput [3]. Optimizing scheduling of transmission and adjustment of the clock frequency technique is used to minimize the consumption of energy for mobile resource constraint device [4]. A task execution framework is proposed which selects the favorable sensors for less energy consumption, optimizing concurrent task execution by removing redundancy [5].

Sensing Techniques

Cloud sensing and optimization of query processing techniques are used so that energy overhead is reduced and improves scalability [6]. Location, context, and activity-aware selective sensing is used to reduce the consumption of energy, storage, and data processing requirements [7]. The cloud-offloaded global positioning system (CO-GPS) which provides sensing devices to assure duty cycle of the GPS receiver device and logging the millisecond raw data from the GPS signal for processing technique is helpful to conserve energy [8]. Collaborative sensing and aggregation of information using trusted middleware provide energy saving [9].

Data Transmission Techniques

II. The optimal decision rule method is used which selects the best bridge node to reduce the transmission energy consumption of every node [10]. Customizable sensor information system model is used to modify data transmission and frequency of data collection to make it energy efficient, and this approach also reduces CO2emissions [11]. A framework for wirelessly powered based on mobile computing under the constraints of deadlines and energy harvesting is proposed to minimize the energy consumption of local computing and maximizing the energy saving for offloading computing [12]. The sensor-cloud integrated platform is used to perform push-pull communication among the three layers of the system architecture for energy-efficient data transmission. This approach uses lesser bandwidth while collecting a high amount of data from the user [13]. The Senud compression algorithm which is used to reduce replicated data as a result of transmission energy consumption is minimized, and this method is also suitable for high volume numerical data [14].

Advanced System Designing

A cloud orchestration approach which supports dynamic workflow among service components is used to coordinate services based on cloud computing, as a result, it provides energy efficiency [15]. A data prediction model is used so that energy consumption is minimized in a sensor-cloud infrastructure [16]. A self-managed sensor-cloud technique is used to automatically carry out energy management, management of the event, aggregation of data, and management of connection and to handle critical applications. This approach also provides fast response in case of an emergency [17].

Data Processing

III. Cloud-based query management and optimization techniques are used to lower the cost involved in sensing, reduces the maximum uncertainty, and propagates the query-evaluated result intelligently to reduce energy consumption [18]. A framework of integrated WSN and cloud is proposed which avoids network disruption, reduces loss of data, and increases network lifetime. Using this technique, sensor data can be accessed anywhere at any time with the help of the internet [19].

Load Balancing Techniques

IV. A novel selection of node strategy reduces the consumption of energy by using the concept of cooperation in which tasks are partitioned optimally and can be executed by the sensors. As a result, computing resources are optimally used [20]. Cloud-assisted monitoring of complex event is used to select the service access point scheme for QoS support under energy-efficient constraint. This approach is reliable, takes less response time, and is energy efficient [21].

V. PROBLEM DEFINITION

WSN consist of N sensors positioned randomly in the network. The sensors send data via gateway to cloud. The sensors use geographic routing protocols to send data to gateway and from the gateway the data is sent to cloud. The data sampling rate at sensors can be configured on the sensors by instructions sent by cloud.

If the sensors are configured with higher data sampling rate, the energy of WSN reduces fast and the storage at cloud increases. If the sensors are configured with lower data sampling rate, the energy of WSN reduced slowly and storage at cloud increases slowly but the accuracy of measurement is affected and user has to wait to get the real values. The data sampling rate parameter must be optimized to best value to save energy consumption and storage without affecting the accuracy of sensor values.

VI. PROPOSED SOLUTION

The proposed solution applies Fuzzy logic to determine the optimal data sampling rate. The data sampling rate is kept different for different sensor nodes.

The data sampling rate is decided based on following factors.

1. The energy of sensor node (E)
2. The data query frequency at node (DQ)
3. Deviation of sensor value from other node in neighborhood area (DVN)
4. Time correlated value difference in sensor data. (DVT)

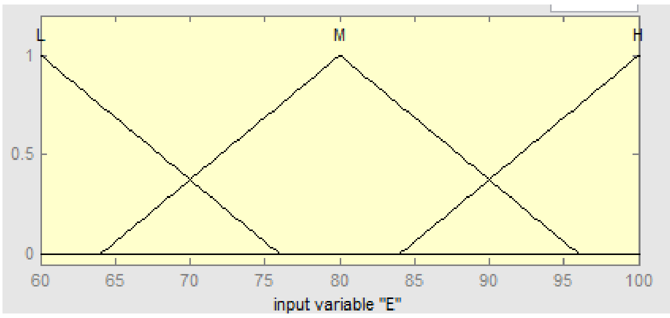
The data sampling rate is proportional to the residual energy at the sensor node.

For a sensor which is queried most for data, the most recent value must be given as result, so higher sampling rate must be kept.

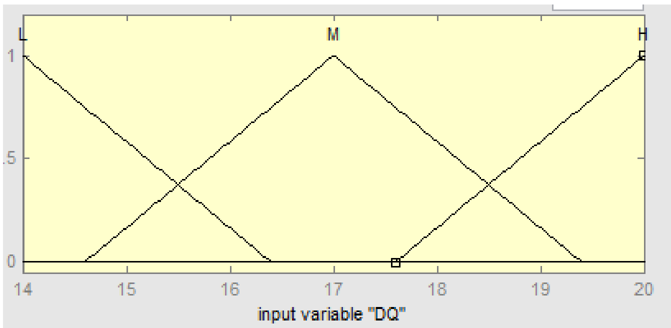
If the sensor value is deviating from its neighbor area sensors, the value of sensor cannot be derived using spatial diversity, so higher data sampling must be done for that sensor.

If the sensor values over period of time is showing very less deviation, then the further value can be predicted using time correlation, so its sampling rate can be kept lower.
The four parameters E, DQ, DVN, DVT are fuzzified into three ranges L(Low), M (Medium) ,H (High) . The data sampling rate(DS) is also fuzzified to three ranges of L(Low), M(Medium),H(High).

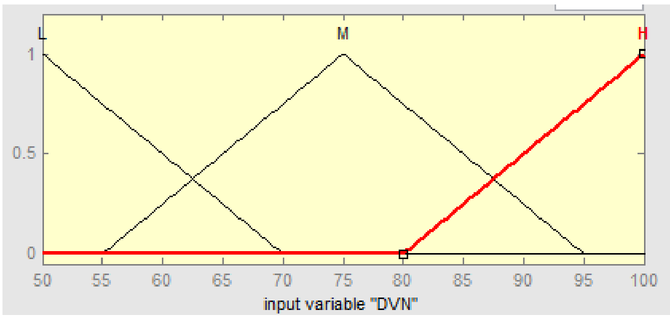
The fuzzy variable Energy (E) is fuzzified below



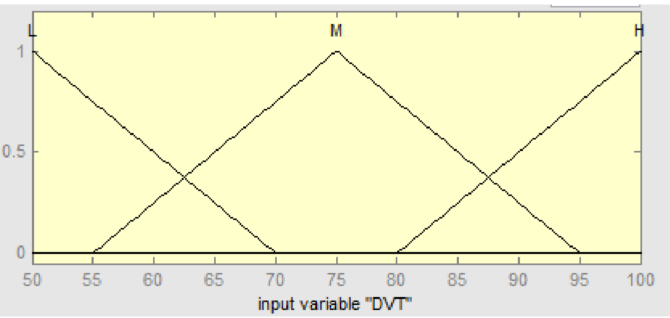
The fuzzy variable Data Query(DQ) is fuzzified below



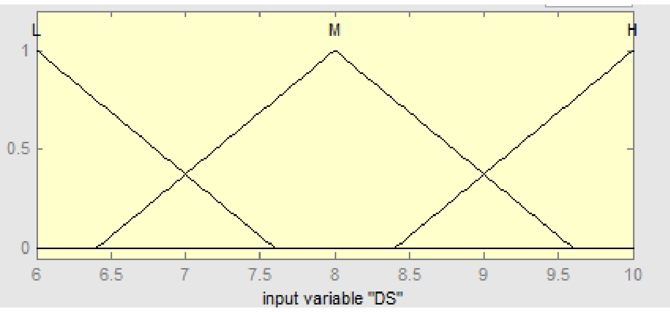
The fuzzy variable Deviation from Neighbourhood (DVN) is fuzzified below



The fuzzy variable Deviation from Time (DVT) is fuzzified below



The data sampling rate (DS) is fuzzified below



The rule set for converting input parameters to output sampling rate is given below.

E	DQ	DVN	DVT	DS
L	L	L	L	L
L	L	L	M	L
L	L	L	H	L
L	L	L	L	M
L	L	M	M	L
L	L	H	H	L
L	M	L	L	H
L	M	M	M	L
L	H	H	H	L
M	M	L	L	H
M	M	M	M	L
M	H	H	H	L
H	M	L	L	H
H	M	M	M	H
H	H	H	H	M

The data sampling rate of each sensor is decided by using fuzzy logic above and the values found is set to the sensors node. The sensor samples at the configured sampling rate and sends vis gateway to cloud.

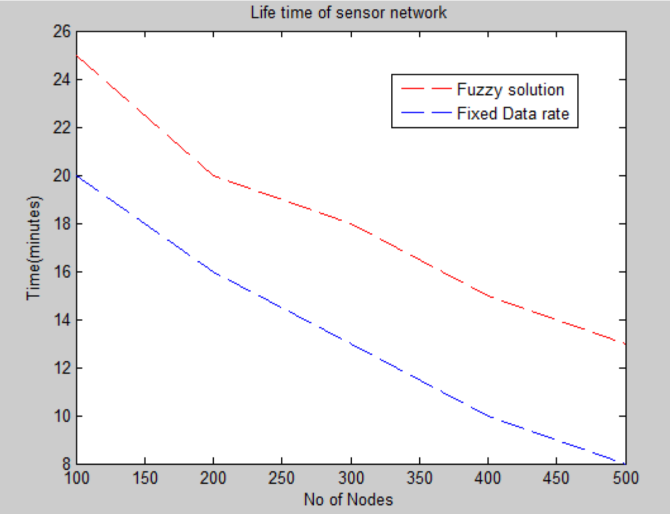
VII. RESULTS

To test the performance of proposed solution we implemented the solution on NS2. The simulation was conducted with following parameters

Parameters	**Values**
Number of Nodes	100 to 500
Communication range	100m
Area of simulation	1000m*1000m
Data sampling rate	0 to 10 times per second
Simulation time	30 minutes
Interface Queue Length	50
MAC	802.11
No of Gateway	1

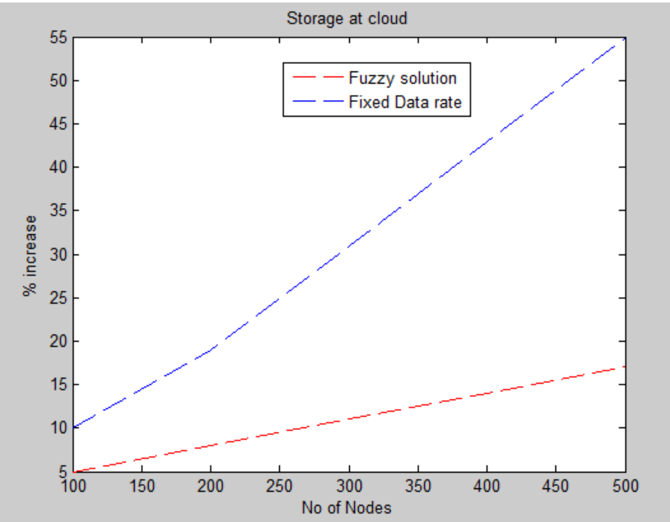
The performance was compared against fixed data sampling rate of 5 times per second for all sensor nodes.

The life time of sensor nodes was measured for different network size. Life time is measured as time for first node death and plotted below



From the results it is proved that with the fuzzy solution to adapt the data sampling rate , the energy consumed is less and due to it the life time of the network is increased.

The storage at cloud is measured in terms of percentage increase and plotted below



From the results, we see that storage at cloud increases at slower rate in the Fuzzy solution compared to fixed data rate.

VIII. CONCLUSION

In this work, we have explained fuzzy solution to adjust the data sampling rate to optimize the energy consumption at sensor node and storage at cloud. The solution is based on four input parameters which drastically influences the data sampling rate. By adjusting the data sampling rate different for different sensor nodes in the network , the storage and energy is optimized. Through simulation results, it is proved that the proposed Fuzzy solution is able to achieve increased life time and reduced increase in storage consumption.

REFERENCES

1. M. Yuriyama and T. Kushida, “Sensor-cloud infrastructure - physical sensor management with virtualized sensors on cloud computing,” in 2010 13th International Conference on Network-Based Information Systems (NBiS), pp. 1–8, Takayama, Gifu, Japan, September 2010.

2. K. Ahmed and M. Gregory, “Integrating wireless sensor networks with cloud computing,” in 2011 Seventh International Conference on Mobile Ad-hoc and Sensor Networks (MSN), pp. 364–366, Beijing, China, December 2011.

3. P. You, H. Li, Y. Peng, and Z. Li, “An integration framework of cloud computing with wireless sensor networks,” Lecture Notes in Electrical Engineering, vol. 214, pp. 381–387, 2013.

4.A. Alamri, W. S. Ansari, M. M. Hassan, M. S. Hossain, A. Alelaiwi, and M. A. Hossain, “A survey on sensor-cloud: architecture, applications, and approaches,” International Journal of Distributed Sensor Networks, vol. 2013, no. 2, Article ID 917923, 18 pages, 2013.

5.X. Ma, Y. Cui, and I. Stojmenovic, “Energy efficiency on location based applications in mobile cloud computing: a survey,” Procedia Computer Science, vol. 10, pp. 577–584, 2012.

6.Y. Cui, X. Ma, H. Wang, I. Stojmenovic, and J. Liu, “A survey of energy efficient wireless transmission and modeling in mobile cloud computing,” Mobile Networks and Applications, vol. 18, no. 1, pp. 148–155, 2013.

7.K. Suto, H. Nishiyama, N. Kato, and C. W. Huang, “An energy-efficient and delay-aware wireless computing system for industrial wireless sensor networks,” IEEE Access, vol. 3, pp. 1026–1035, 2015.

8.T. Dinh and Y. Kim, “An efficient interactive model for on-demand sensing-as-a-services of sensor-cloud,” Sensors, vol. 16, no. 7, 2016.

9.R. Dalvi and S. K. Madria, “Energy efficient scheduling of fine-granularity tasks in a sensor cloud,” in International Conference on Database Systems for Advanced Applications (DASFAA), pp. 498–513, Hanoi, Vietnam, 2015.

10.W. Zhang, Y. Wen, K. Guan, and D. Kilper, “Energy-optimal mobile cloud computing under stochastic wireless channel,” IEEE Transactions on Wireless Communications, vol. 12, no. 9, pp. 4569–4581, 2013.

11.H.-L. Shi, D. Li, J. F. Qiu, C.-D. Hou, and L. Cui, “A task execution framework for cloud-assisted sensor

networks," Journal of Computer Science and Technology, vol. 29, no. 2, pp. 216–226, 2014.
12.S. Sivakumar and A. Al-Anbuky, "Dense clustered multi-channel wireless sensor cloud," Journal of Sensor and Actuator Networks, vol. 4, no. 3, pp. 208–225, 2015.
13.G. Tanganelli, C. Vallati, and E. Mingozzi, "Energy-efficient QoS-aware service allocation for the cloud of things," in 2014 IEEE 6th International Conference on Cloud Computing Technology and Science (CloudCom), pp. 787–792, Singapore, December 2014.
14.T. Ojha, S. Bera, S. Misra, and N. S. Raghuwanshi, "Dynamic duty scheduling for green sensor-cloud applications," in 2014 IEEE 6th International Conference on Cloud Computing Technology and Science (CloudCom), pp. 841–846, Singapore, December 2014.
15.S. Sen, A. Misra, R. Balan, and L. Lim, "The case for cloud-enabled mobile sensing services," in Proceedings of the First Edition of the MCC Workshop on Mobile Cloud Computing (MCC'12), pp. 53–58, Helsinki, Finland, August 2012.
16.C. Perera, D. S. Talagala, C. H. Liu, and J. C. Estrella, "Energy-efficient location and activity-aware on-demand mobile distributed sensing platform for sensing as a service in IoT clouds," IEEE Transactions on Computational Social Systems, vol. 2, no. 4, pp. 171–181, 2015.
17.J. Liu, B. Priyantha, T. Hart, H. S. Ramos, A. A. F. Loureiro, and Q. Wang, "Energy efficient GPS sensing with cloud offloading," in Proceedings of the 10th ACM Conference on Embedded Network Sensor Systems (SenSys '12), pp. 85–98, Toronto, ON, Canada, November 2012.
18.R. Loomba, L. Shi, B. Jennings, R. Friedman, J. Kennedy, and J. Butler, "Energy-aware collaborative sensing for multiple applications in mobile cloud computing," Sustainable Computing: Informatics and Systems, vol. 8, pp. 47–59, 2015.
19.X. Sheng, X. Xiao, J. Tang, and G. Xuey, "Sensing as a service: a cloud computing system for mobile phone sensing," in 2012 IEEE Sensors, pp. 1–4, Taipei, Taiwan, October 2012.
20.S. Chatterjee, S. Sarkar, and S. Misra, "Energy-efficient data transmission in sensor-cloud," in 2015 Applications and Innovations in Mobile Computing (AIMoC), pp. 68–73, Kolkata, India, February 2015.
21.V. J. Lawson, R. T. Watson, and L. Ramaswamy, "C-SenZ-IS: a customizable sensor IS model for energy efficient SaaS," in 2015 48th Hawaii International Conference on System Sciences (HICSS), pp. 3414–3423, Kauai, HI,