International Journal of Energy Optimization and Engineering
Volume 10 • Issue 1 • January-March 2021

Agent-Based Improved Neuro-Fuzzy for Load Balancing in Sensor Cloud

Prashant Sangulagi, Bheemanna Khandre Institute of Technology, Bhalki Karnataka, India
https://orcid.org/0000-0003-2979-832X

Ashok Sutagundar, Basaveshwar Engineering College, Bagalkot Karnataka, India
https://orcid.org/0000-0003-1494-7150

ABSTRACT

Sensor cloud paradigm is a trending area for most of the applications. It collects the information from physical sensors and stores it in cloud servers, and it can be accessed anywhere. Energy optimization is one of the crucial issues in sensor cloud as sensed information are unprocessed and directly saved into cloud server thereby increasing energy consumption and delay which leads to unbalancing in the network. In this paper, agent-based improved neuro-fuzzy optimization is proposed to avoid transmission of redundant information into cloud along with load balancing among all nodes for equal energy consumption. The agents work on behalf of node, migrate to each node in the cluster, collect information, and submit to CH minimizing node energy consumption. Neuro-fuzzy along with weights is used to improve information accuracy and reducing energy consumption to improve overall network lifetime. Result shows that less energy is consumed along with minimum delay and information with great accuracy is saved into cloud server.

KEYWORDS

Agents, End-to-End Delay, Energy Optimization, Load Balancing, Network Lifetime, Neuro-Fuzzy, Sensor Cloud

INTRODUCTION

Sensor cloud is a new trend in the present scenario to overcome from the drawbacks of Wireless Sensor Network (WSN). The issues of WSN are node deployment, battery energy, bandwidth, routing, QOS, robustness, storage, fault mechanisms and security requirements (Akyildiz, 2002). The energy consumption is a trending issue in WSN from past many years and still many researchers are working on different scenarios to create an optimal system which consumes less energy for transmission and reception. Multiple research has been carried out to create energy efficient WSN (Sulieman, 2018; Anastasi, 2009; Jones, 2001; Karaki, 2004; Kumar, 2009; Ehsan, 2010; Tang, 2010; Zaman, 2016). Energy efficient WSN leads to improved network efficiency and network lifetime.

On the other hand, cloud computing is an efficient information storage paradigm which facilitates the end users to access the information at any point of time irrespective of where they are located. Cloud computing can improve the storage and processing capacities of WSN with great extent. Hence the sensor cloud is used to improve the overall system like gathering the data, accessing the information, processing the data and importantly storing the data (Madria, 2014; Alamri, 2013), this removes the long term energy consumption issue of WSN and improve its lifetime. Sensor cloud is a unique sensor data storage, visualization and remote management platform that support cloud computing to afford

DOI: 10.4018/IJEOE.2021010102

data scalability, rapid visualization and user programmable analysis (Lan, 2010). The sensor cloud is used in wide variety of applications like, health monitoring, environmental monitoring, transportation, agriculture, military and industrial monitoring (Alamri, 2013; Jit 2010).

Load balancing is one of the network energy saving technique in sensor cloud where it decides which node to be used for proper load distribution in the network. The load balancing is required to enhance the network lifetime and to make all the nodes operable in the network (Dumbrava, 2010; Zhang 2009). Load balancing technique not only concentrates on all nodes but it also concentrates on specific nodes which plays a vital role in the network. The considerable parameters for measuring performance efficiency of load balancing are reliability, adaptability, fault tolerance, throughput and waiting time (Yana, 2018). Commonly load balancing algorithm has five major components, transfer policy, selection policy, location policy, information policy and load estimation policy as discussed in (Amar, 2011). The highlighting features of load balancing are, reduced task waiting time, minimized task response time, maximum utilization of resources and throughput, improves reliability, stability and allows further modification if system prefers so (Manekar, 2012). The load balancing techniques are broadly classified into two types, static load balancing technique and dynamic load balancing technique (Rajguru, 2012). The static load balancing refers certain predefined information and does not consider status of the system. The dynamic load balancing on the other side improves better load distribution with additional communication and computation overhead. The static load balancing further has many techniques namely, round robin algorithm, randomized algorithm, central manager algorithm and threshold algorithm. The dynamic load balancing types are ant colony algorithm, central queue algorithm, honeybee foraging behavior, local queue algorithm, least connection algorithm and nearest neighbour algorithm (Kushwaha, 2015; Randles 2010).

Optimization is the technique to select the best from the available alternatives. In other words optimization can be defined as the process of finding the best condition for a function that gives desired benefit within minimum cost. Selection of optimization depends upon type of problem. Some of the problems are classified as, existence of constraints, nature of equations and admissible values of the design variables. Energy optimization is one of the important constraints for load balancing and prolonging the network lifetime for great extent. Energy optimization techniques can be used for single as well as multi-dimensional optimization problems and they vary for different types of problem statement. The popular optimization techniques categorized as mathematical programming, stochastic process techniques, statistical methods and modern or nontraditional techniques. The popular optimization techniques are genetic algorithm, simulated annealing, ant colony optimization, particle swarm optimization, neural network (Joshua Thomas J, 2019; Kadan, A. B, 2020), fuzzy logic optimization (Mitiku T, 2020) and combinational Neuro-fuzzy optimization (Sreenivas, 2015; Lin, 2011; Zhiwei, 2018). Neural network offers advantages such as adaptation, fault tolerance, learning generalization and parallelism. The outcome of neural network is used to fine tune membership functions of fuzzy systems that are employed as decision making systems for controlling equipments. Both are clubbed so that knowledge is achieved using neural network and performance along with accuracy is improved using the fuzzy rules (Collotta, M, 2014). These two combinations improve the energy optimization with great effect which is not achievable using individual optimization.

Agents are autonomous, self organized, light weight, goal oriented and acts independently without human intervention to fulfill the user's desires. The definition of agent differs from application to application. The agent paradigm is well suited for e-commerce, real time monitoring & processing, communication and networking (Brewington, 1999; Wooldridge, 2002). Agents can also be used for load balancing in cloud computing and wireless sensor network (Singh, 2015). Agents are of two types, static agents and mobile agents. Static agents are stationary agents and they don't have the mobility functionality. Mobile agents have the ability to migrate from one point to another and collect the required information, finally come back from where it is initiated within stipulated time.