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Energy-Efficient Cloud-Integrated Sensor Network Model Based on Data Forecasting Through ARIMA

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ABSTRACT

An energy-efficient model for sensor-cloud is proposed based on data forecasting through an autoregressive integrated moving average (ARIMA). Generally, all the user requests are redirected to the wireless sensor network (WSN) through the cloud. In the traditional approach, user requests are generated every 15 minutes, so the sensor must send data to the cloud every 15 minutes. In the current approach, the sensors within the WSN communicate with the cloud every two hours. The data forecasting technique addresses most of the user requests using the ARIMA one-step-ahead forecasting model in the cloud. This results in less frequency of data communication, thereby increasing the battery life of the sensor. The ARIMA-based forecasting model provides better accuracy because of fewer temperature data changes with respect to the current temperature, for the next two hours. The proposed method for the simulation in the sensor cloud system consumes significantly less energy than the traditional approach, and the error in forecasting becomes highly negligible.

KEYWORDS

ARIMA, Data Forecasting, Sensor-Cloud, WSN

INTRODUCTION

WSN has been used for various applications recently. Many applications like monitoring environments such as measuring temperature, humidity, speed of the wind, and rainfall need the help of WSN. Many physical sensors combine and transmit data wirelessly in the WSN. The cloud system provides storage, infrastructure, and other resources on rent to the users. Many organization uses cloud services to minimize the cost of buying sever and other resources like platform, software, and other services. The Sensor-cloud provides sensing service to the end-users using the cloud systems. The end users can use the sensor, which is attached in the cloud by the sensor owner. The sensor owner gets paid once the users utilize the sensor. By using the virtualization technique, one sensor can be accessed by multiple end-users. Sensor-cloud must utilize energy efficiency due to the limited lifetime of the

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battery in the sensor node. The cloud system consumes more energy for running the servers in the datacenter.

A sensor node $S_{k'}$ uses P_k amount of energy to transmit data to another sensor $S_{k''}$ with a rate of data transmission R_k. Here $1 \leq k', k'' \leq n$, and $k' \neq k''$. Here P_k can be calculated (Guha et al., 2007) as follows:

$$P_k = P_1 + P'R_k P_{rec} d^{\beta} \tag{1}$$

where:

P_1 = the ideal power expenditure of sensor node $S_{k'}$
P′ = constant
R_k = the data rate of sensor $S_{k'}$
P_{rec} = minimum energy required for successfully decoding at $S_{k''}$
d = distance between the sensor nodes $S_{k'}$ and $S_{k''}$

β lies between 2 and 6, depending upon the environment.

The consumption of energy in the WSN depends on the data rate and the distance between the nodes. More transmission of data can make the battery dry soon. Generally, user queries are generated fifteen minutes, so the sensor responds to the queries by sending data to the cloud every fifteen minutes. So forecasting schemes that forecast future sensor data for two hours in advance within the cloud system can save energy for the sensor network as sensors send data every two hours to the cloud system.

BACKGROUND

Dent (1977) provided suggestions for maximum likelihood estimation for effective search process computation. Ansley and Kohn (1985) derived the likelihood for non-stationary ARIMA for missing values in the time series. Geurts and Whitlark (1994) proposed a technique for marketing to maximize the forecasting accuracy for sales. The research carried out by Stein and Lloret (2001) used the ARIMA model to forecast the bottom temperature of water for three cities. This model obtained better results in comparison to other models. The paper by Abdel-Aal (2004) proposed an alternative abductive networks approach where dedicated hourly models were taken into account. This approach produced a better result than the other unsophisticated forecasts. Davis and Ensor (2006) proposed a method for the detection of outliers for the environment data. Aslanargun et al. (2007) proposed a model to forecast tourists' arrival using nonlinear components that perform better than others. Tektaş (2010) implemented a model that took into account the adaptive network-based Fuzzy Inference system and ARIMA to analyze better weather forecasting. Campano and Barrios (2011) proposed a method to detect structural change using time series analysis. Deore et al. (2012) allocated maximum tasks upon fewer Virtual Machines (VMs) to decrease energy consumption and test the virtual box's cloud environment by using a scheduling method. Cai et al. (2014) proposed a combined forecasting method which performs better in time- series. Du et al. (2014) presented an algorithm that enables the VMs to handle the maximum number of tasks possible with the least energy consumption by keeping the time duration of each VM within a specific deadline. The research carried out by Dong et al. (2015) proposed a method in which the tasks were scheduled to minimize server count. The response of datacenter time was limited for implementing the most-efficient-server-first scheme consumed less energy. The computing resources get enhanced or dropped under the given load of works to improve resource utilization, and reduction in energy consumption is proposed by Chen et al. (2015). Chen et

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