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Research Article

A Novel framework using Stochastic Gradient Decent Search for optimizing Wireless Sensor Networks

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Abstract

In the past three decades, Wireless Sensor Network (WSN) has become a leading area of research. Now days, WSN plays vital role for all kind of humanoid applications like research, automation, robotic industries etc. Most of the researches are contributing through their research works for WSN to simply the infrastructure, data communication, Security and shortest path signal communication. Eventually we come across the WSN issues and stated that Load Balancing, Security and shortest distance for transmission. Artificial Intelligence is the powerful technology for many kinds of applications. In this paper, we used Stochastic Gradient Decent Search (SGD) algorithm for optimizing the WSN signals.

Key words: WSN, SGD, AllJoyn

I. INTRODUCTION

Ad-hoc networks are playing vital in our human life and other application perspectives because of their ease of usage and Infrastructure Independence. Wireless Sensor Networks (WSN) is in this kind of Ad-hoc network family, it is consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions. Recent advances in micro-electro-mechanical systems (MEMS) technology have boosted the deployment of wireless sensor networks (WSNs) [1]. With the wider applications of WSN technology in many different areas and for different uses like hospital management, disaster management, social environments and military and surveillance system monitoring;

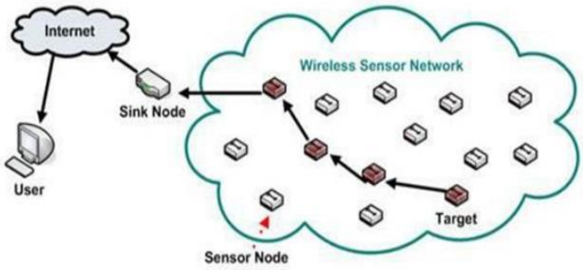

Fig. 1 WSN Architecture

The above figure depicts how the sensors formed the network. Sensor nodes are responsible for collecting the environmental information and sending it towards a sink node, which receives the information gathered by the network and delivers it to the end user.

Challenges in WSN

1. Limited power and resources
2. Heterogeneous Network Environment
3. Dynamic Network Topology
4. Integrated with real world applications
5. Algorithm compatibility
6. Data centric
7. Quality of Service
8. Maintenance

We come across the above stated parameters are very big challenging for WSN; even though many researchers are contributing their vision on the area. Because of wider usage of WSN, it increases the new challenging also. WSNs are composed of a large number of sensor nodes; therefore, an algorithm for a WSN is implicitly a distributed algorithm. In WSNs the scarcest resource is energy, and one of the most energy-expensive operations is data transmission. For this reason, algorithmic research in WSN mostly focuses on the study and design of energy aware algorithms for data transmission from the sensor nodes to the base stations. Data transmission is usually multi-hop (from node to node, towards the base stations), due to the polynomial growth in the energy-cost of radio transmission with respect to the transmission distance. We confine the three major challenging area of WSNs are Load Balancing, Signal distribution with routing algorithm and Security.

Localization is one of the vital requirements of WSN, where deployed nodes in a network discover their positions. For instance, Local Area Network is confined with gateway and single hop transfer mechanisms with software implementations without any special hardware. However, in many common environments, localization is more difficult. GPS-based localization may be unreliable indoors, under forest canopies or in natural and urban canyons. For example, GPS is used for high precision asset tracking in but fails indoors. Signal strength-based solutions similarly fail when there is a high degree of RF multipath or interference

In this paper, we contribute Load balancing such as how to organize the signals in proper storing system and optimize the signals using Stochastic Gradient Decent Search (SGDS) algorithm.

II. Related Work

Anfeng Liu et. al [1] have discussed three phase disjoined multipath routing techniques for WSN and introduced secret sharing algorithm. Based on secret sharing algorithm, the SEDR scheme depressively and randomly delivers shares all over the network in the first two phases, and then transmits these shares to the sink node. Secure and Energy-efficient Disjoint Routing (SEDR) scheme to maximize both the network lifetime and the security; Specifically, SEDR focuses on increasing security by utilizing available energy to forward shares with disjoint routes.

R. Gopinathan and P. Manimegalai [2] have addressed energy and latency aware packet forwarding protocol and how it selects the forwarding nodes diligently to ensure reliability and uses the any cast forwarding technique to handle energy and latency in the network along with successful data delivery at the destination

Sean P. Engelsont et. al [10] have discussed about the mobile navigation and how it revisit the place in the implementation of WSN. It is necessary to revisit particular, individual places, not just places with some interesting property. It provides an initial exploration of system architectures for networked sensors. The investigation is grounded in a prototype "current generation" device constructed from off-the-shelf components

Shu hui MA et. al [3] had depicted the energy consumption of the network and improves its balance, especially when on heavy traffic load in dense network. This simulation result shown that 20 times better in balancing the energy consumption compared with geographical random forward protocol.

Geoffrey Werner-Allen [8] et.al had developed a reliable data-collection protocol, called Fetch, to retrieve buffered data from each node over a multihop network. They addressed how to use time stamps with 256 blocks of with sequence number identification. During transmission, a sensor node fragments each requested block into several chunks, each of which is sent in a single radio message. The base-station laptop retrieves a block by flooding a request to the network using Drip, a variant of the TinyOS Trickle6 data-dissemination protocol.

Nirupama Bulusu et.al [9] had addressed the classification of the design space and work done in the area of localization. They had depicted proposes a method for coarse-grained localization based on an idealized radio model, and demonstrates its validity and applicability in outdoor unconstrained environments. Their research described a simple implementation of the model and presents initial results.

Chung-Horng Lung et. al[4] had addressed DHAC algorithm Distributed Hierarchical Agglomerative Clustering for distributed environments. In their work, data set is consists with HELLO message for obtaining other neighboring nodes like received signal strength, energy and feature prosperities. Then they implemented Euclidian distance for location with qualitative data and finally mixed with two or more clusters for obtaining the less energy consumption. They used following parameters

1. 100 homogeneous sensor nodes
2. Node Numbers
3. Bandwidth
4. Threshold distance

5. Message bytes
6. Sensing field range

Eventually, energy 72 % of the total energy will be consumed in data transmission in WSN. Some of the clustering algorithms will overcome the consumption problem and eliminating the redundancy in number of transmission. Hence, few researchers have contributed multi hop routing algorithm for less energy consumption.

III. Implementation

In this section, we used WSN datasets for optimizing the data signal with Artificial Intelligence techniques. We collected more than 10,000 dataset which emits the WSN signals from various applications. Usually Sensors generate signals in a time of interval and it should be stored as streaming database storage system. We used AllJoyn router for storing this data set as dynamically and statically. Figure 3.1 depicts the workflow of this research work; first phase, collecting the dataset from the data repository and it has been stored as LIBSVM format with adaptation of AllJoyn router for aggregating the signal from the different Sensor signals. Extract the features from the signals and used for train the data with AI mechanism.

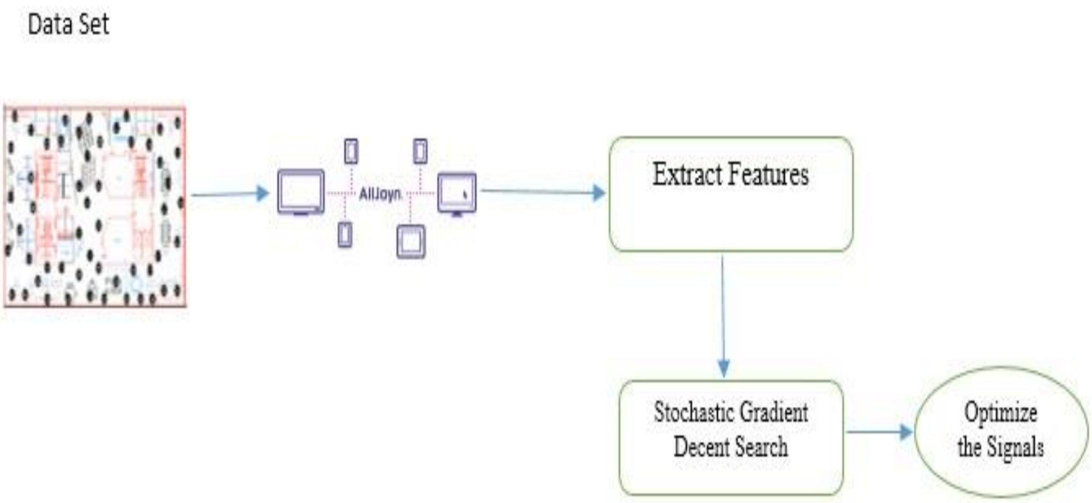

Fig. 3.1 WSN optimizing framework

3.1 Dataset

We have collected numerous data set from data repository with different perspectives of usages. Data are stored in CSV or libsvm format with useful parameters like Received Signal Strength (RSS) about of bytes or packets and frequency rand with destination and arrival information.

# Clock (millisecond): 250						
# Duration (seconds): 120						
# Columns: time	avg_rss12	var_rss12	avg_rss13	var_rss13	avg_rss23	var_rss23

0	32	4.85	17.5	3.35	22.5	3.2
250	40.5	1.12	14	2.24	21.75	1.3
500	40.5	2.6	11.33	4.5	18.25	5.31
750	34.5	1.5	20.67	2.87	19	2.83
1000	34.5	1.5	21.25	3.27	18.25	4.38
1250	32.25	2.86	21.5	2.29	23.5	2.6
1500	35.75	4.44	13	3.94	22.75	1.79
1750	41.5	1.12	13	2.94	19.75	1.79
2000	39.75	3.27	8.5	7.5	20	2.45
2250	30.75	2.49	20.25	4.92	16.33	5.25
2500	32.75	0.43	17.75	3.27	20.5	6.06
2750	32.75	2.17	19	4.06	21	3.67
3000	32.25	6.18	16.5	4.72	22.75	3.03
3250	41.25	0.83	14.25	3.9	22.25	1.3
3500	42.33	2.49	14	4.42	18	2.45
3750	34.25	1.79	20.5	4.56	19.5	2.69

Table 3.1 Dataset WSN examples

3.2. AllJyon

AllJoyn is a collaborative open source software framework that allows devices to communicate with other devices around them [5]. It has been written in C, C++ and Java technologies and supported both Linux and windows platforms. It is emphasizing the client –server model for itself like Producer-Consumer model applications. AllJoyn framework is flexible, promotes proximal network and cloud connection is optional [5]. It incorporates with onboard, configuration, Notification, Control panel and Device model services.

3.3 Feature Extraction

Feature extraction is used to the features or groups from the dataset for simplifying the larger volumes of information. It emits the features from the given variable set and used to train the network for next process in decision making. In this section, we extracted WSN signals clock, rss value, average rss, frequency, arrival, destination node's strength and time bound are analyzed for optimization process.

3.4 Stochastic Gradient Decent Search Algorithm

This neural network of deep learning contains various layers of processing each having several neurons. Every neuron will take many different inputs weighted and finally produce one single output fed into the subsequent layer [6]. Gradient descent is an iterative algorithm that starts from a random point on a function and travels down its slope in steps until it reaches the lowest point of that function.

Algorithm

Step 1: Compute the gradient – Slope of objective function for WSN features

Step 2: Pick the WSN random initial value from the descriptive parameters

Step 3: Update the gradient

Step 4: Find features step_size = gradient*rate _learning (flexible parameters)

Step 5: New parameters = old parameters – step size

Step 6: Continue with 3 – 5 until get the optimum.

In our dataset, 10,000 data points for WSN signals and analyzed 10 features; each iteration 10,000 X 10 = 1, 00,000 data points will be calculated. Hence no data point is missing for optimizing the section. Mathematically, Gradient Descent is a convex function whose output is the partial derivative of a set of parameters of its inputs. The greater the gradient, the steeper the slope [7].

$$for\ i\ in\ range\,(m):$$
$$\theta_j = \theta_j - \alpha\,(\hat{y}^i - y^i)\,x_j^i$$

In SGD, it uses only a single sample, i.e., a batch size of one, to perform each iteration. The sample is randomly shuffled and selected for performing the iteration. Since only one sample from the dataset is chosen at random for each processing; the path taken by the algorithm to reach the minima is usually noisier than your typical Gradient Descent algorithm.

```
model = keras.Sequential()

model.add(layers.Dense(128, kernel_initializer='rss', input_range=(32,)))

model.add(layers.Activation('avg'))

opt = keras.optimizers.Adam(learning_rate=0.03)

model.compile(loss='categorical_crossentropy', optimizer=opt)
```

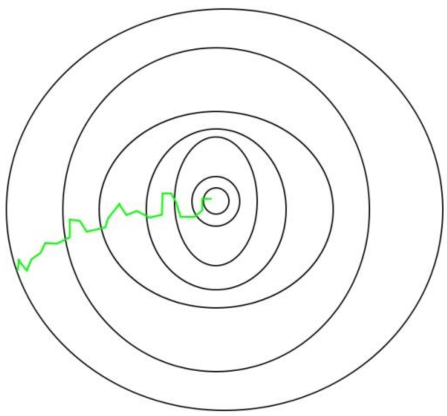

Fig 3.2 Iteration Model of SGN

Computation:

DEF SGD (FUN, THETA, ALPHA, NO.ITERATIONS)

PARAMETERS (OPTIMZE F, INITIAL POINT THETA, NUM)

```
start_iter = 0
    theta = theta0
    for iter in xrange(start_iter + 1, num_iters + 1):
        _, grad = f(theta)
          # there is NO dot product ! return theta
        theta = theta - (alpha * grad)
```

In the above computation method, optimized function will be fixed and to be achieved by the trained parameters. For instance, our rss value is 42.5 for the network transmission we iterate the remaining parameters to reach nearly 42.5 and indentify the minimum and maximum slope and eventually we got the optimum

IV. RESULT AND DISCUSSION

We analyzed with Keras using python tool with following WSN parameters with distinguished procedures of execution. The simulation result says that existing or traditional convention Neural Networks performs slow compare than our proposed Stochastic Gradient Decent Search (SGD) algorithm.

Accuracy WSN Data Point	Neural Network	SGD
10	95.21	97.18
50	96.27	98.12
100	96.28	98.56
1000	94.25	96.25
10000	94.25	96.5

Table 4.1 Comparison Accuracy

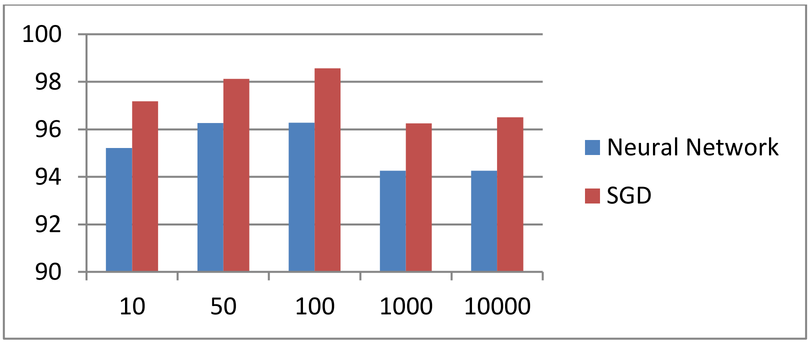

Fig 4.2 Comparison chart NN with SGD

V. CONCLUSION

In contemporary world, WSN plays imperative role for ruling the humanoid applications and other research works. Many of the researchers are contributing short path communication between the nodes without or minimum packet loss in their research simulation. We addressed the novel paradigm for optimize the network parameters with AI techniques. Because we used Hadoop platform for storing and analyzing the part of our work. We used Keras tool for simulation of our work. Instead of using ancient model, this process will be atomized easier for any WSN application. We stated that this generic framework will be applicable for robotic field, smart environments and mobile communication. In our future work, we will implement the security features to obtain the betterment of the entire signal transmission over the network.

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