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Data Filtering and Storage using WSN and Artificial Neural Networks

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Abstract: The state of art development in wireless communication has led to the development of various wireless sensors. The wireless sensors are versatile and low priced and can be used for several different applications like temperature monitoring, health monitoring. However there are certain limitations to the use of such sensors. Two of the few major limitations of wireless sensor networks are its inability to store data and transmit it back when needed and unreliability i.e. the sensor, due to its limited channel, bandwidth and lack of security becomes unreliable. The objective of this paper is to address the above two problems. The unreliability of the system is tackled by using artificial neural networks for data filtering i.e. the data at the sensor gateway is transmitted to an artificial neural network which filters out redundant data and also compresses the relevant data. The data is then transferred to cloud for storage where it can be accessed when needed. This can have various applications in data monitoring, prediction of natural disasters, weather forecast etc.

Keywords: WSN, Artificial neural network, Sensor gateway.

I. INTRODUCTION

Sensors are devices which detect or measure a physical property and records, indicate, or otherwise respond to it. Wireless sensors for long have been used for remote sensing and monitoring of dynamically changing physical values like temperature, pressure etc. Wireless sensors have thus been used for various applications but the usefulness of these relatively inexpensive and highly versatile sensors is limited by limited bandwidth and their inability to process or store data for future reference/usage.

A sensor is connected to a system/network through an access point known as a gateway. A gateway is a node which is compartible only with the associate/assigned system so as to avoid interference between the various networks. The gateways form a medium of communication between the user and the system, transferring the sensor reading to the user and user commands/codes to the sensor along with alerting the user of potential faults or errors.

Artificial neural networks is series of network or circuit which are composed of nodes or neurons designed based on the working of human brain Used for circuits that adapt to changing condition or learn from the surrounding these are of various types namely supervised, unsupervised and reinforced. A supervised neural network is the one in which an input is given and based on that weighted output is produced. Such supervised neural networks can be used to sense a pattern in the values of the sensor reading and design a pattern for future predictions.

Compression is the process of reducing the size of data without compromising the information. The compressed data can however not be used as it is, it has to be decompressed for it. The process of compression and decompression increases the complexity of the system at the same time reducing the space, time and resources used to transmit the information.

The objective of this paper is to propose an advanced wireless sensor network which has enhanced bandwidth along with the ability to store the results for future use. For this we use Artificial Neural Network's supervise learning to filter the data and also compress it hence reducing redundant data and store the data into cloud from where it can be accessed at a later point in time. The artificial neural network technique used is called "Back propagation of errors" which is a generalised delta rule. This include a system with set of data of both input and output and the new outputs are found based on the pre-existing values. Among a set of values, the most relevant value is taken up compressed and stored in cloud. This is used best with open loop networks as errors may creep in if the loop is closed.

II. PRE-EXISTING SYSTEMS AND PROPOSALS

The pre-existing wireless sensor networks have been in use for decades with no or little change in the basic design. Their popularity can be attributed to various factors like versatility, inexpensiveness, etc. However they can't be used when the area of coverage is huge because in that case the accuracy decreases also the sensors are unable to hold so much of data. The sensors in the above case are burdened with the tasks of data collection, aggregation and selection

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algorithm thus reducing the efficiency the result of which is data collision and hence the usability of wsn is reduced.
Several proposals have been put up so as to improve wireless sensor networks these include Using distributed data compression and hierarchical aggregation in large scale sensor networks to minimise the consumption of energy. Using various data compression algorithms for energy constraint devices in delay tolerant network. Using adaptive (neural networks) sampling techniques for node discovery. However none of the above could address the two aspects of problems defined above.

III. PROPOSED METHOD

In the system designed, the data sensed by a cluster of wireless sensor network is transmitted to the sensor gateway in form of bit streams without any processing as such. A separate gateway is present for each sensor cluster. Once the data reaches the gateway, it is processed by artificial neural networks. The artificial neural network is trained to check the values of the input, if the value falls in a given range i.e. the most acceptable region it is discarded, and if the value is too high or too low than expected it is compressed and store in the cloud thus reducing further computation and making the system fast and efficient. This also reduces the bandwidth requirement and the storage space required. The neural network predicts the values of next real time input thus increasing the speed. The data processed by the neural network is compressed and automatically transmitted to the cloud gateway for storage into the cloud at regular intervals. The neural network filters out the values which are in the range of given values and stores only the values that are too high or too low thus reducing the bandwidth, traffic and increasing the speed and storage capacity of the gateways. Also since no processing is done at the sensor end, the power consumption and storage speed is also reduced. The accuracy of the system is improved by sensing the data frequently. The compressed data is decompressed using Deflate algorithm and stored in the cloud for further use/processing if needed.

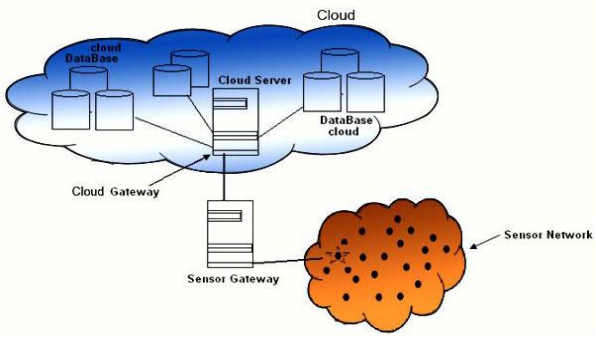

Figure 1: System Architecture

The above figure shows the architecture of the system designed. The sensor network shown consists of a cluster of sensors that will sense the data. The sensor gateway is used to collect the data sensed by sensor. The data then goes through a series of artificial neural network which uses back propagation meathod to filter out the data as needed the data is then compressed and deflate algorithm is used to store the data into cloud in desired format. There is another gateway called the cloud gateway which is the reception point of the cloud. The deflate algorithm decompresses the data and stores it in the cloud

3.1 Neural Networks

Neural networks are a series of self-learning artificial neural networks modelled after the human brain and hence are able to adapt to and learn from the changing environment. There are different types of neural networks namely, supervised, unsupervised and reinforced. In this project we use supervised neural networks for their ability to find a pattern in the inputs and outputs based on their weights and predict the future trend.
The data input to the neural network is filtered based on a given margin, if the data lies in a given range, it is removed any fluctuations from the given range is stored. The algorithm used is “Back Propagation Algorithm” for compression which finds anomalies in data stored.

3.2 Back Propagation Networks

Back propagation or "backward propagation of errors", is the artificial neural network algorithm used here. The network is trained based on the outputs of various inputs and hence finds a pattern wherein it predicts the future output based on the pattern developed based on the outputs of all previous input. This process works in a cycle of two processes namely propagation and weight update these two processes are repeated until the network becomes mature i.e. it reaches a satisfactory performance level.
Propagation process takes place by the forward propagation of the input of the training pattern used through the neural network in order to generate the propagation output activations and backward propagation of the propagation's output activates through the neural network using the training pattern target in order to generate the deltas of all output and hidden neurons Weight is updated for each weight-synapse by multiplying its output delta and input activation to get the gradient of the weight and then bringing the weight in the opposite direction of the gradient by subtracting a ratio of it from the weight. This ratio influences the speed and quality of learning. It is called the learning rate. The weight gradient’s sign indicates the regions where the error is increasing, hence pointing out the region where the weight needs updating.

ALGORITHM

Initialize the weights in the network (often small random values)
do
For each example in the training set
O = neural-net-output (network, e) // forward pass
T = teacher output for e
Compute error (T - O) at the output units
compute delta_wh for all weights from hidden layer to output layer //

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Backward pass
compute delta_wi for all weights from input layer to hidden layer //
Backward pass continued
Update the weights in the network
Until all examples classified correctly or stopping criterion satisfied
Return the network

When this is integrated with the cloud, the data is periodically updated into the cloud so as to act as a storage unit with great storing capacity thus allowing us to remove the data from the sensor memory so that fresh data can be stored and the data processing work is left to the gateways allowing us to save the energy of the sensors and hence improving its efficiency.Since only the anomalies in the data are stored and transmitted, less bandwidth is enough for the transmissions and traffic is also less.

3.3 DEFLATE ALGORITHM

Deflate is a compression procedure that combines two algorithms together. On one hand a dictionary based algorithm equivalent to LZ77 is used to encode recurring. On the other hand Huffman code is applied for entropy coding. The procedure was introduced together with the ZIP data format. The specification of the deflate procedure is published in RFC 1951: "DEFLATE Compressed Data Format Specification" (by P. Deutsch) . Deflate is applied in context with different data formats, e.g.: 7z (7-Zip) GZIP. An algorithm is written in such a way that based on the time interval specified it will invoke the script for compression and perform the compression of collected data. The interval can be programmed based on the storage capacity of the sensor. It finds duplicated strings in the input data. The second occurrence of a string is replaced by a pointer to the previous string, in the form of a pair (distance, length).Distances are limited to 32K bytes, and lengths are limited to 258 bytes. Deflate Algorithm removes the redundant data collected by each sensor and then compresses the data and sends to a trained neural network.

Flow Chart:
The flowchart of the proposed system

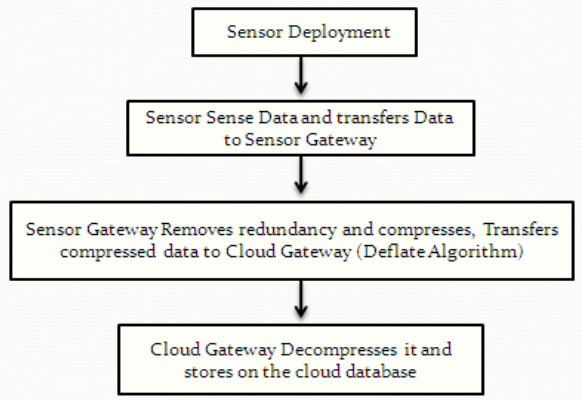

Figure 2: Flow chart

Step 1: Each sensor nodes are activated upon simulation from required software.
Step 2: The nodes sense data and transfer the data to sensor gateway.
Step 3: The gateway performs the task of removing redundancies and compressing (Deflate Algorithm) useing Neural network Algorithm.
Step 4: Cloud gateway decompresses it and stores on the cloud database.

3.4 ADVANTAGES

- Since the size of data sent is reduced, transmission energy required is less.
- The storage limitation of sensors, as pre-stared, is overcome.
- The problem of retransmission is solved.
- Quality of service is improved.
- Power consumption is reduced as there is no need for processing at the sensor end.
- The processing is done within the gateway hence saving lot of energy of the sensor node.
- The bandwidth is utilized more effectively.

IV. SIMULATION AND RESULTS

The tables below show the enhancement obtained using the proposed system as it is apparent, the battery time is improved by the collection of data from sensor gateway without processing. Data storage and processing is made easier by the updating into the cloud also the data is permanently stored.Neural network filters the data, which is also compressed before transmission. So the bandwidth requirement for transmission is less.

Table 1 Size of data collected under various conditions

Scenarios	Before Compression	After Compression (without using neural networks)	After compression (using neural networks)	TIME(Sec)
1	18.1Kb	12.5 Kb	6.24 Kb	16
2	36.2Kb	25 Kb	12.48 Kb	30
3	55.5 Kb	33.7 Kb	17.4 Kb	49

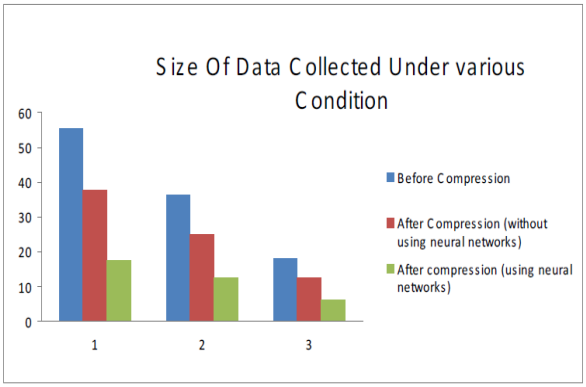

Figure 3 Size of data collected under various conditions

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V. CONCLUSION

The data collected using the sensors is filtered at the sensor gateway using trained neural networks to remove the redundant data. The size of the data is then further reduced by compression and sent to the cloud gateway. There the data is decompressed and finally uploaded to the cloud, where it is stored for future references .As the sensors nodes are limited by battery and storage we are making use of sensor and cloud gateways for removing redundant data .Data is compressed to reduce the bandwidth needed to transmit it to the cloud.

Here, the type of wireless sensor networks considered is homogenous. The same architecture could be used for heterogeneous networks that can be considered for monitoring different types of applications by a single gateway. We can use encryption technique for few important data also. Work is currently being carried out in these areas.

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