Applications of NMF and RBM for image compression in Wireless sensor network

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Abstract— Wireless sensor networks (WSNs) are resource constraint, limited power supply, bandwidth for communication, processing speed, and memory space. One possible way to achieve maximum utilization is applying data compression on sensor data. An attempt to make the comparison between Ad-Hoc On-Demand Distance Vector (AODV) routing, Dynamic Source Routing (DSR) and Destination Sequenced Distance Vector (DSDV) routing protocol based on their performance parameters like packet delivery ratio, throughput, the end to end average delay and energy consumption. Image compression is done using Non-negative Matrix Factorization (NMF) and Restricted Boltzmann Machine (RBM) methods. In this project, a raw image is considering and compression is done using Non-negative Matrix Factorization (NMF) and Restricted Boltzmann Machine (RBM) methods in MATLAB2015 and calculates parameters like PSNR and Compression ratio. The compressed image is sending through an NS2 simulator.

Keywords--AODV, DSR, DSDV, NMF, RBM, WSN

I. INTRODUCTION

The Wireless sensor network consists of number of sensors which are separated and dedicated for uses like mentoring various physical conditions from the outside world. It also arranges the collected data at its key location .In the present world, wireless communication and sensor technology greatly demand efficient wireless sensor networks. . With low-cost CMOS camera availability had developed Wireless Multimedia Sensor Network (WMSN) i.e., networks of wirelessly interconnected devices that can retrieve multimedia content such as video and audio streams, still images, and scalar sensor data from the environment.

Compared to conventional wired networks and scalar data Wireless Sensor Networks (WSNs), WMSN encounters more problems due to the limited resources in memory, processing, bandwidth, complexity, and power consumption. As a result of massive data being transmitting over WMSN, more power dissipation per each node, and consequently data compression is needed to decrease data size. WMSNs are dividing into three parts sensing, processing, and transmission. Among these operations, it is recognized that processing and transmitting are the most consuming power operations. Suitable compression algorithms would reduce the data size, power consumption and increase the sensor's lifetime. For different applications such as traffic monitoring, environmental monitoring, etc. transmission of an image in wireless sensor network should be sent efficiently; this can achieve when network satisfies the requirement like less memory, improving the throughput of the network, for this requirement raw image should be compressed. Here non-negative matrix factorization (NMF) and Restricted Boltzmann machine (RBM) compression techniques are considered and transmitted through the wireless sensor network.

II. PROPOSED NMF, RBM ALGORITHMS

A. NMF ALGORITHM

Use the imread function in MATLAB to read the input image as the experimental sample to generate the original matrix V. The original matrix data V is normalized, and the sum of the normalized rear column vectors is 1. A normalized matrix ny is obtained. Using MATLAB to write the non-negative matrix factorization program to get the reduced base matrix W and coefficient matrix H.

The normalized matrix nv is projected onto the base matrix W generated in the previous step to obtain the new coefficient matrix myH. Using the multiplication principle of non-negative matrix factorization, the matrix W obtained in step 4 and the coefficient matrix H is obtained in step 5 are multiplied to obtain the reconstructed matrix .This is shown in fig 1.

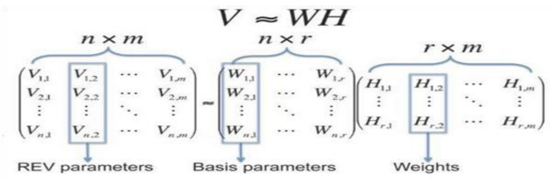

Fig 1 Matrix representing V=WH

A. RBM ALGORITHM

The image matrix is inputted into the multilayer RBM network. The network contains an input layer and multiple hidden layers. The connection weights and bias between input layer units and hidden layer units can be adjusted to make the hidden layer output equal to the input of the input layer as much as possible. The output of

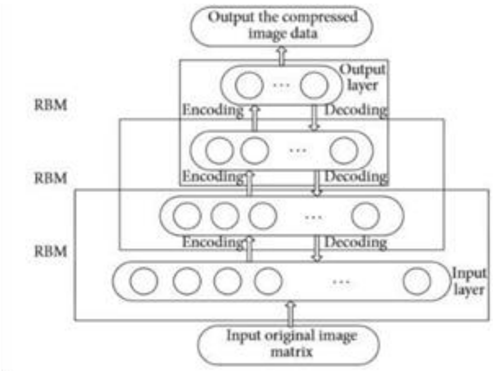

Figure 2: Image compression using multilayer RBM

RBM hidden layer in the first layer is inputted into the RBM in the second layer. When the number of hidden layer units is smaller than that of the input layer units, it means that the hidden layer can adequately express the input of the input layer. The transformation from the input layer to hidden layer can be seen as the process of compression encoding. The bottom input layer consists of M×N neural units. Each neural unit represents a pixel in the M×N image. The number of hidden units can be determined based on the image compression ratio. Image decoding is the inverse process of the image compression coding process. The compressed image is inputted into the topmost layer and then is decoded from layer to layer; the bottom level outputs the original image.

III. ROUTING PROTOCOLS IN WSN

This paper analyses AODV, DSR and DSDV performance . These routing protocols are analyzed based on the metrics such as energy consumption, throughput, packet delivery ratio and average end-to-end delay and is presented with the simulation results obtained by NS-2 simulator.

A. Varying the number of nodes

Protocols	**Packet delivery Ratio (%)**	**Throughput (kbps)**	**End to end Delay (ms)**	**Energy Consumption (Joule)**
AODV	**24**	**210**	**0.92**	**4.0**
DSDV	**56**	**425**	**0.42**	**3.2**
DSR	**32**	**225**	**0.85**	**3.8**

TABLE 1 Simulation parameter (Varying number of nodes)

B. Varying the speed of the nodes

In this circumstance by varying the speed (2ms, 5ms, 8ms) of the node then measure the parameter values such as packet delivery ratio, delay, and throughput and energy consumption by keeping the number (10nodes) of the node and size of the network area constant. The maximum speed which is an important factor is fixed at around 10 m/s and the total number of nodes is fixed at 10 for each scenario of 5ms pause time keeping all other parameters fixed. The performances like PDR, End-to-End-Delay, Energy consumption and Throughput are measured by varying the pause time .

IV. RESULTS AND DISCUSSION

In this paper, a raw image (256*256) is considered and compressed using NMF and RBM technique. In MATLAB, PSNR and Compression ratio parameters are calculated and compared between those above two compression techniques based on those parameters. After compressing the image it is transmitted through NS2 simulators using sensor nodes and by applying various scenarios. The parameters like packet delivery ratio, average end-to-end delay, throughput and energy consumption are calculated

A. NMF compression

Fig 3 Original, compressed image in NMF

Topology area	600m×600 m	Maximum speed	**10ms**
Pause		UDP	
Time	5ms	traffic	Multiple

Figure 4 Original, compressed image in RBM

A. Comparison parameters of NMF and RBM in terms of Compression ratio and PSNR

Table 1 Compression ratio and PSNR values for NMF and RBM technique for compressed image

PARAMETER	NMF	RBM
COMPRESSION RATIO	3.1059	4.1071
PSNR	27.6199	30.6483

B. Graphical representation

It can be seen that DSDV has a better PDR value when compared to DSR & AODV for each set of connections. This is because in the time waited at a node, DSDV can find an alternate route if the current link has broken whereas AODV and DSR are failed to establish immediately.

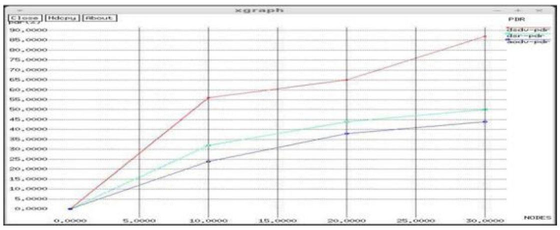

Fig 5 PDR comparison between DSDV, DSR and AODV routing protocols for different number of nodes

The number of nodes was varied (10, 20,30) each time in Fig 7.8.The throughput was calculated at destination node during entire DSDV shows higher throughput than the DSR and AODV. As it can be clearly seen from the graph that a good throughput can be obtained in DSDV routing protocol. Among these three routing protocols DSDV is better than other two routing protocols and DSR have slightly higher throughput than AODV.

The AODV has lower throughput than other routing protocols shown in fig 7.8 and fig 7.9.

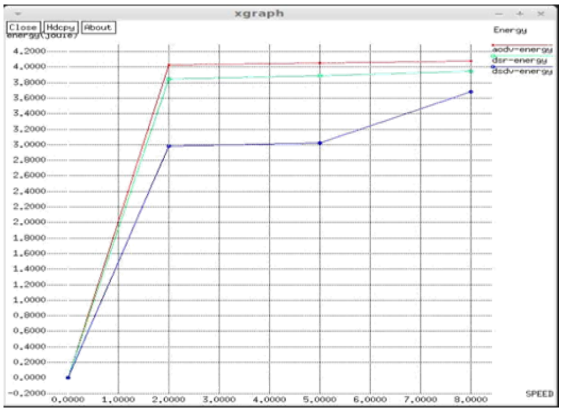

Fig 6 Throughput comparison between DSDV, DSR and AODV routing protocols for different number of nodes

It is seen that AODV has more routing overhead that DSR & DSDV for any range of pause time.. It searches for alternate paths if the current route breaks by flooding the network with RREQ packets. Hence AODV incurs more routing overhead than DSDV & DSR. This overhead leads to unnecessary consumption of energy and the energy is depleted more quickly in the network

It can be seen that DSDV has a better average delay than AODV due to the fact that if a link break occurs in the current topology, DSDV would try to find an alternate path from among the backup routes between the source and the destination node pairs. If a link break occurs in DSR, the packet would not reach the destination due to unavailability of another path from source to destination, and in AODV only singular paths exist between a source and destination node.

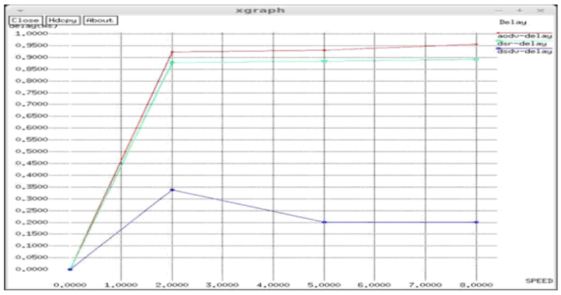

Fig 7 End to end delay comparison between DSDV,DSR,AODV protocols

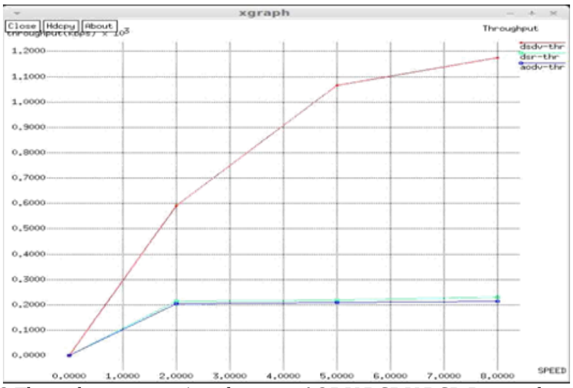

Fig 8 Throughput comparison between AODV,DSDV,DSR Protocols.

C. Output parameters for AODV, DSDV and DSR routing protocols

Table 2 Parameters for different number of nodes

Protocols	Packet delivery Ratio (%)	Throughput (kbps)	End to end Delay (ms)	Energy Consumption (Joule)
AODV	**24**	**210**	**0.92**	**4.0**
DSDV	**56**	**425**	**0.42**	**3.2**
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Table 3 Parameters for speed of the nodes (8 ms)

V. CONCLUSION

In this paper it was observed that RBM techniques achieves better PSNR than NMF algorithm when image is compressed and sent through WSN. .Compression ratio is better for RBM than NMF algorithm. Image is transmitted using the AODV, DSR, DSDV protocols. DSDV performance is the best considering its ability to maintain connection by periodic exchange of data's. As far as Throughput is concerned, DSDV and DSR perform better than the AODV even when the network has a large number of nodes. when a network has larger number of nodes DSDV is preferred and DSR is used when number of nodes are less for transmitting an image through WSN. When number of nodes are more End-to-End Delay is very less for DSDV.

VI. REFERENCES

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