REVIEW ARTICLE

SAMRIDDHI Volume 15, Issue 1, 2023 Print ISSN: 2229-7111 Online ISSN: 2454-5767

Data Traffic Reduction in Wireless Internet of Things Using Deep Compressive Sensing and Reconstruction Algorithm

Hemant Rajoriya, Ritesh Sadiwala

Department of Electroncis and Communication, RKDF University, Bhopal, India

ABSTRACT

Companies across a wide variety of sectors are rapidly moving to IoT to boost productivity, understand better clients in order to provide better customer service, enhance decision-making, and maximize the profitability of their businesses. But having these advantages, there is a drawback in using this technology, that large amount of data transmission creates congestion or traffic inside the network thus to reduces such drawback the technique namely compressed sensing was used. This paper reviews the Internet of things (IoT), traffic or congestion in the network, compressed sensing.

Keywords: Internet of Things, Compressed Sensing, Network Traffic.

SAMRIDDHI : A Journal of Physical Sciences, Engineering and Technology (2023); DOI: 10.18090/samriddhi.v15i01.32

INTRODUCTION

Modern wireless technologies have dramatically explored the scope of Iot environments while extending IoT devices' sensory abilities. A few technological advances, including artificial intelligence (AI), edge computing, and compressed sensing, have traditionally been introduced to Internet of Things (IoT) in effort to match user's requirements and offer particular services.[2,3]

IoT networks will undoubtedly face major data traffic overwhelm issues. For example, because of limited bandwidth and instability channel conditions (*e.g.,* traffic, colliding, and interruption) could induce lag time or latency, leading to decision-making for time moment process. Furthermore, gathering and handling a massive volumes of information from multiple kinds of IoT sensing devices becomes cost-effective and ineffective using a centralized IoT server.

To overcome these drawbacks, the gathered information should initially be compressed before being sent to the fusion centre *via* optimized paths to reduce the high energy. Advanced information compression and transmitting strategies, on the other hand, may take up a lot of onboard energy. As a result, the chosen method must provide long-term effective operation while minimizing energy usage.

COMPRESSED SENSING

Compressed sensing (CS) strategies have already shown commitment in signal compression to confront the massive volume of data problems, leading to faster compression rates with less energy usage whilst also achieving the necessary distortion levels. The collected signals are first projected onto a lower dimension using a random matrix to compress them. The compressed signals are then sent to a neighboring terminal and gadget. Eventually, CS recovery methodologies can be used to recover the old signal so that it can be processed and evaluated. Conventional CS, on the other side, focuses on weak-pattern signals. In previous times considerable work has been done on modeling such source data using the structural characteristics of the signals to improve the performance and speed of CS reconstruction algorithms because of the growing number of source data that contain sparse or low-rank structures.

Compressed sensing is mainly remembered for locating exact or approved by the relevant to inherently unknowable linear systems of equations that cannot be solved using conventional linear algebra methods. It demonstrated that sampling at the Shannon–Nyquist rate isn't impossible any longer. In a nutshell, a high percentage of measurement techniques determined by multiplying a suitably large signal by a well-defined matrix can be managed to recover. As a result, Compressed Sensing has attracted a lot of attention

Corresponding Author: Hemant Rajoriya, Department of Electroncis and Communication, RKDF University, Bhopal, India, e-mail: hemantrajoriya2525@gmail.com

How to cite this article: Rajoriya, H., Sadiwala, R. (2023). Data Traffic Reduction in Wireless Internet of Things Using Deep Compressive Sensing and Reconstruction Algorithm. *SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology,* 15(1), 182-185.

Source of support: Nil

Conflict of interest: None

---

from both academia and industry as a useful signal processing platform for multimedia data compression.

Consider a real valued, finite length, one dimensional, discrete time signal x, which can be viewed as an M × 1 column vector in R^M with elements x[m], m = 1, 2, ..., M. Any signal in R^M can be represented in terms of a basis of M × 1 vectors $\{ u_i \}_{i=1}^{M}$. Let U be an M × M orthonormal matrix where the i–th column is the i–th basis vector u_i . Then the signal $x \in R^M$ can be expressed as a linear combination of these basis vectors by

$$x=\sum_{i=1}^{M} z_i u_i$$

$$x=Uz$$

where z is the M × 1 column vector of weighting coefficients $z_i = \langle x,u_i \rangle = u_i^H x$ and $\langle \cdot \rangle$ denotes inner product. With x in the time or space domain and z in the U domain, it is obvious that x and z are identical representations of the signal. If the signal x is a linear combination of just S basis vectors, it is S–sparse.

By acquiring compressed signal representation directly, CS techniques handle sparse signals. In this situation, a general linear measuring procedure that calculates D < M internal products between x and a vector collection $\{\gamma_j\}_{j=1}^{D}$ as in $y_j = \langle x, \gamma_j \rangle$. The measurements yj are then placed in a D 1 vector y, with the measurement vectors structured as rows in a D M matrix.

$$y = \Gamma x = \Gamma U z = \Theta z,$$

Where the measurements are not chosen in an adaptive way, meaning that the measurement matrix is set and does not depend on the signal x, the original signal x can be properly reconstructed using D measurements where D<<M and D >>S. The next stage in compressive sensing is to create the measurement matrix Γ and reconstruction algorithms to achieve this goal.

LITERATURE REVIEW

Liang *et al.*[1] proposed a convolution-based transfer learning CS (CTCS) model to reconstruct the compressed signal based on transfer learning. Ultrawide band (UWB) radar echo signal and Mnist hand-written data set are selected to evaluate the performance of CTCS. It is verified that the proposed model outperforms other traditional reconstruction algorithms in 6G-IoT under different noise levels, measurement numbers, and signal sparsities. Latency and reliability was not observed in this model.

Zhang *et al.*[2] propose a deep unfolding model dubbed AMP-Net. Rather than learning regularization terms, it is established by unfolding the iterative denoising process of the well-known approximate message passing algorithm. Furthermore, AMP-Net integrates deblocking modules in order to eliminate the blocking artifacts that usually appear in CS of visual images. In addition, the sampling matrix is jointly trained with other network parameters to enhance the reconstruction performance. The model was not evaluated under noisy scenario.

Jiang *et al.*[3] proposed a compressed sensing with dynamic retransmission (CSDR) algorithm to guarantee high data reconstruction accuracy, network lifetime, and energy utilization. The CSDR algorithm dynamically determines the max packet loss retransmission times of different nodes according to their residual energies, for Internet of Thing (IoT) devices with relative high energy consumption, fewer max retransmission times is adopted to maintain a longer network lifetime. For energy-rich IoT devices, more max retransmission times is used to improve the data transmission accuracy and the performance of data reconstruction. In this paper, it was observed that in most cases, there is still a large amount of energy remaining in the far sink area of the network, which can be fully utilized to improve network performance.

Zhang *et al.*[4] pointed out that packet loss is an important factor affecting the CS algorithm's performance. They divide the WSN into multiple clusters, the cluster head (CH) is responsible for the collection of the compressed sampling data in the cluster, and then it generates the CS observation vectors and forwards them to the base station. Therefore, the impact of packet loss and other errors is limited to one cluster. However, this method does not substantially reduce packet loss, nor does it analyze the impact of packet loss on CS and its range of application, which will affect its performance in WSNs where packet loss occurs frequently.

Chen *et al.*[5] designed a two-stage dynamic topology compression sensing (DTCS) data collection algorithm to improve the efficiency of data collection in wireless sensor networks with dynamic topology. First stage, a collection tree using the maximal independent set method is constructed. Second stage, the sensor nodes in the network obtains the local topology information by mutual communication. Then, the adaptive strategy is adopted to maintain the collection tree according to the topology changing.

Ramachandra *et al.*[6] discussed that the compressed sensing (CS) paradigm uses simultaneous sensing and compression and provides a technique for efficient image/video acquisition. Author investigated the use of compressed sensing for image acquisition in IoT based applications that suffer from energy, bandwidth and storage limitations.

Sun *et al.*[7] proposed an abnormal event detection scheme based on compressed sensing. Due to the low energy consumption target constraints, the cluster-head often has no ability to collect all the data of the terminal nodes. Therefore, a sparse model of terminal nodes is proposed, which is applied to the WSNs scenario. When the number of nodes to be collected is far beyond the ability to collect data, the sparse model is used to propose a distributed abnormal event detection scheme. Each cluster-head uses the compressed sensing method to collect the data. During the procedure, data collection rules are in accordance with the sparse parity check matrix of LDPC code. In the fusion center, the compressed sensing equations of these cluster-heads will be combined into a complete equation. Then the Message Passing algorithm based on Tanner Graph is used to reconstruct the abnormal event sensing results of the sensor nodes.

DATA TRAFFIC OR CONGESTION

The number of information migrating all over a computer server at any particular time is referred to as network congestion. Data packets are subdivided into network congestion and transmitted over a network prior being reconfigured by the able to receive computer device. The system has two types of traffic circulations: north-south and east-west. Due to an abnormally high volume of congestion can imply slow data rates or spotty voice over Ip (voip (VoIP) interconnection, congestion has an impact on network reliability. Since an abnormally high volume of congestion could be an indication of a threat, congestion is also linked to security. Network managers make a decision how some sorts of congestion should be handled by network systems such as routers and switching devices to efficiently control bandwidth. Network congestion is divided into two types: real-time and non-real-time. When choosing a willing to host membership, people or businesses should consider two factors: the quantity of included internet bandwidth and the monthly data traffic (bandwidth). Megabytes or gigabytes are used to convey both value systems. The internet space criterion specifies the maximum number of files you can store on your hosting provider. The number of information you can send from the domain controller to the Internet is determined by the allowed data traffic per month. In those other words, how much data can visitors install per month from your site? Because we're dealing with large numbers, this figure is usually demonstrated in gigabytes.

Real-time Congestion

Congestion that is considered significant or crucial to company activities must arrive on time and in the best possible condition. VoIP, video-conferencing, and surfing the web are real examples network congestion.

Non-real-time Traffic

Also recognized as finest congestion, is congestion that network managers regard as being less essential than real-time traffic. Two instances are file transfer protocol (FTP) for online publishing and email systems.

Congestion is a state in the network level that can occur when data is transmitted using the packet swapping technique. It is a scenario wherein a network's capacity for carrying packets is exceeded, resulting in incoming messages traffic and thus slowing the data transfer rate.

Non-compactable or outdated Hardware: The network manager ought to be sensitive to the needs of the businesses and should be up to date on the latest components so that equipment such as switching devices, access points, and servers can be modified with the best possible hardware configuration.

Congestion can be caused by poor design process and subnet: Yes, a badly designed system can cause congestion. As a result, this same network layout must be highly optimized because every part of the system can communicate effectively. Furthermore, the subnet should be adequately seized according to the traffic.

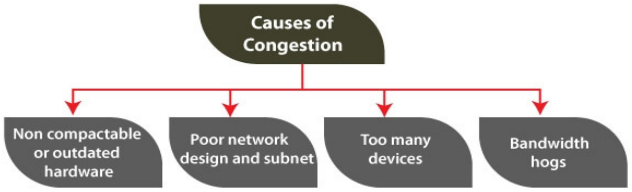

Figure 1: Causes of congestion

Too Many Devices: A system with several things attached will experience congestion, as each network has a low bandwidth and traffic ability. As a result, when there is more equipment in your system than you stipulated, NPM will detect them and alert you to deal with them.

Hog of Bandwidth: The term "bandwidth hog" refers to a user or device that absorbs more data than other devices. Bandwidth hogs will consume more resources, potentially causing congestion. NPM (Network Performance Monitors) will alert you if any device consumes more connection speeds than expected.

INTERNET OF THINGS

Gadgets connected to the IoT start operating in lossy surroundings, resulting in fluctuations and heterogeneous congestion trends. The open systems interconnection (OSI) prototype layers underpin the communication activities of these gadgets. The reduced OSI layers can be improved to improve the device's communications infrastructure. Although the medium access control (MAC) and physical network processes can be described using mathematical formulas, device-constrained assets necessitate complex algorithms. IoT nodes employ carrier-sense multiple access with collision avoidance (CSMA/CA) to obtain a channel. The devices enhance network efficiency by avoiding collisions induced by nodes trying desperately to send packets simultaneously. Collisions in the network are one of the most difficult problems in wireless communication technology.

IoT has recently emerged as among the most key inventions of the twenty-first century. Presently that we can hook up each and every day things to the internet via embedded systems, such as kitchenware, automobiles, heating systems, and motion detectors, smooth conversation, procedures, and things is possible. The interconnection, network management, and information exchange protocols that the deployed IoT applications largely determine these web-enabled equipment use. IoT can also use artificial intelligence (AI) and computer vision to make data collection process much easier and much more dynamic.

Material entities can start sharing and gather information with nominal human intervention services at affordable computer technology, the cloud, big data, business intelligence, and digital applications. Digital systems can record, monitor, and modify each interaction between connected things in today's hyper-connected world. The traditional and cyber worlds collide, but they work together.

An IoT ecosystem is made up of digital internet sensors that gather, transmit, and respond to information from their surroundings using embedded systems such as processing units, sensor systems, and communication hardware. By connecting to an IoT gateway or other edge device, Connected systems can share sensor data that is either sent to the cloud for analysis or analyzed locally. These devices may occasionally interact with each other and rely on the data they receive. So even though individuals can communicate with the gadgets to put them in place, consider giving them commands, or access information, the devices do the majority of the work excluding human intervention.

CONCLUSION

Companies in a wide range of industries are rapidly adopting IoT to increase productivity, better understand clients in order to provide better customer service, improve decision-making, and increase profitability. However, despite these benefits, this technology has a disadvantage in that large amounts of data transmission cause congestion or traffic within the network. To mitigate this disadvantage, compressed sensing was used. This paper provides an overview of the Internet of Things, network traffic or congestion, and compressed sensing.

REFERENCES

[1] J. Liang, L. Li and C. Zhao, "A Transfer Learning Approach for Compressed Sensing in 6G-IoT," in IEEE Internet of Things Journal, vol. 8, no. 20, pp. 15276-15283, 15 Oct.15, 2021, doi: 10.1109/JIOT.2021.3053088.

[2] Z. Zhang, Y. Liu, J. Liu, F. Wen and C. Zhu, "AMP-Net: Denoising-Based Deep Unfolding for Compressive Image Sensing," in IEEE Transactions on Image Processing, vol. 30, pp. 1487-1500, 2021, doi: 10.1109/TIP.2020.3044472.

[3] B. Jiang, G. Huang, F. Li and S. Zhang, "Compressed Sensing With Dynamic Retransmission Algorithm in Lossy Wireless IoT," in IEEE Access, vol. 8, pp. 133827-133842, 2020.

[4] C. Zhang, O. Li, Y. Yang, G. Liu, and X. Tong, ''Energy-efficient data gathering algorithm relying on compressive sensing in lossy WSNs,'' Measurement, vol. 147, Dec. 2019, Art. no. 106875.

[5] J. Chen, N. Wang, D. Chen and J. Wan, "An Adaptive Dynamic Topology WSN Data Collection Method Based on Compressive Sensing," 2018 2nd IEEE Advanced Information Management,Communicates,Electronic and Automation Control Conference (IMCEC), 2018, pp. 1376-1379, doi: 10.1109/IMCEC.2018.8469397.

[6] G. Ramachandra and M. S. Bhat, "Compressed Sensing for Energy and Bandwidth Starved IoT Applications," 2018 IEEE Distributed Computing, VLSI, Electrical Circuits and Robotics (DISCOVER), 2018, pp. 131-134, doi: 10.1109/DISCOVER.2018.8674107.

[7] X. Sun, X. Gao and C. Li, "A joint abnormal event detection scheme based on compressed sensing for Internet of Things," 2016 16th International Symposium on Communications and Information Technologies (ISCIT), 2016, pp. 509-513, doi: 10.1109/ISCIT.2016.7751684.

[8] Y. Chen, W. Liu, T. Wang, Q. Deng, A. Liu, and H. Song, ''An adaptive retransmit mechanism for delay differentiated services in industrial WSNs,'' EURASIP J. Wireless Commun. Netw., vol. 2019, no. 1, p. 258, Dec. 2019.

[9] H. Kim, J. Ahn and H. Nam, "Wideband spectrum sensing using low-power IoT device," 2020 International Conference on Information and Communication Technology Convergence (ICTC), 2020, pp. 424-426, doi: 10.1109/ICTC49870.2020.9289566.

[10] M. Amarlingam, P. K. Mishra, K. V. V. Durga Prasad and P. Rajalakshmi, "Compressed sensing for different sensors: A real scenario for WSN and IoT," 2016 IEEE 3rd World Forum on Internet of Things (WF-IoT), 2016, pp. 289-294, doi: 10.1109/WF-IoT.2016.7845487.

[11] M. Shaban and A. Abdelgawad, "A study of distributed compressive sensing for the Internet of Things (IoT)," 2018 IEEE 4th World Forum on Internet of Things (WF-IoT), 2018, pp. 173-178, doi: 10.1109/WF-IoT.2018.8355095.