Analysis of Data Management Schemes of Internet of Things

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Abstract:-

Internet of Things (IoT) represents a set-up in which the sensors devices sense the information and transmit it to the base station. The deployment of this system is done in various applications, still there are some issues occurred in this network as it is dynamic in nature. The IoT is generated from the WSNs (wireless sensor networks). The sensor nodes that assist in sensing the natural circumstances are small sized. Moreover, their utilization is done at distant places which results in higher energy consumption and it is the main issues faced in IoT. The various schemes are designed which can reduce the energy of the sensor nodes and also manage the data. In this paper, various schemes are reviewed for the data management and energy consumption reduction.

Keywords : *IoT, Energy Consumption, Data Management*

DOI Number: 10.14704/nq.2022.20.9.NQ44706 **Neuro Quantology 2022; 20(9):6065-6074**

I. INTRODUCTION

The Internet of Things is providing enormous services for both individuals and industries, from smart home control systems to transportation, healthcare and industrial automation, etc. Its use is increasing day by day for better decision making, planning and better yield [1]. The important properties of this IoT platform lie in exploring various technologies for communication, embedded frameworks and data analytics to generate smart gadgets to perform monitoring, detection, tracking etc., in a smart way. The Internet of Things can be bifurcated into five layers based on its composition and functionality as featured in Fig. 1.

The functions of each layer of the IoT paradigm are as follow:

1) The Perception layer, also called device Layer, is the bottom most layer of the entire paradigm. This main task of this layer is identifying objects and capturing data. This involves different miscellaneous gadgets, for This layer enables all nodes to be allotted an exclusive address equivalent to the web's MAC address, for example RFID gadgets, wired and wireless sensing devices, mobile phones, PDAs, and other gadgets. This layer enables all nodes to be allotted an exclusive address equivalent to the web's MAC address, for example frequency recognition of EPC [2], and is unable to process, filter and transmit it. In the meantime, the data aggregated through this layer can be irregular, and the volume of data is enormous and too much redundant as well.

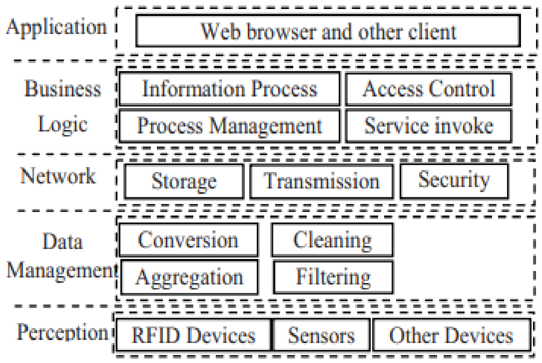

Fig. 1: Common Architecture of IoT

2) The second layer of data management behaves like the middleware of IoT, and is liable to locate and identify objects. Additionally, it uses a variety of intermediary techniques to create heterogeneous data in order to standardize and consolidate the Internet of Things [3]. In the meantime, this layer helps in capturing, screening, processing, deriving and mixing data from the bottommost layer and ultimately translating it into valuable info. It additionally delivers security control, asset portion, faultregulation, struggle demilitarization and different capabilities. It connects the different systems in the IoT, and contributes substantially.

3) The main function of third layer (i.e., network layer) is to arrange and transport the info obtained from the second layer. This layer provides security controls, guarantees effective storing and broadcast of info. It basically includes processing networks such as the Internet and intranets [4]. The network layer data, pre-normalizedby the second layer, employ integrated interaction ideals. It must be able to comply with computer networks that empower the utilities of the layer above it.

4) The fourth layer (i.e., business logic) is accountable to process and handle the info received from the third layer and delivers amenities to the uppermost layer. It also offers entree regulation, procedure managing operations.

5) The uppermost layer (i.e., application layer) makes use of the amenitiesdelivered by layers below it and comply with the necessities of clients, for example, transaction, metropolitan making due, medical care administrations, schooling and logical examination, power frameworks, production network control, individual applications and different elements [5].

A. Need of Data Management in IoT

Performing IoT data analysis requires well-organized management of sensor data from IoT mechanisms. One can detect irregularities and expressive episodes from the data sequence and make decisions actually by applying Complex Event Processing (CEP) techniques. Nevertheless, the processing and analysis of continuously flowing data from heterogeneous networks still poses many dissimilarconcerns, and needs the inception of new technologies and approaches [6]. One main concern in an IoT paradigm relates to whether it is semi-structured or amorphous, making it compliant with the Big Data environment. ConventionalDatabase Management Systems (DBMSs), which require data to be stored and indexed prior to processing, cannot meet the timeliness and scalability necessities of flowing IoT data. Furthermore, for performing investigation and visualization, existentmeasures are generallyunproductive, as they lead to a mismatch between the configuration of the source data and the analyticmechanisms [7]. Eventually, several privacy and security challenges as well as resource inadequacies for example memory, bandwidth and energy must considered when IoT data management systems build data streams on a bigger scale. The sources of data in IoT can be, and often are, in a very large range of endpoints that produce data in enormous volume.

B. IoT Data Features

This section presents a review of typical features of IoT data. Generally speaking, IoT data has five different features:

1) Heterogeneity: Heterogeneity: IoT involves different features in various data templates to characterize the condition of "things". These data templates show change from number to character likewise with semi-organized and shapeless data, for example, sound and video sequences [8].

2) Impreciseness: Impreciseness of the generated data is amongst the main factors that limit the wide-ranging use of IoTs. For example, tests demonstrate that RFID structuresare able to receive small percentage of accurate data due to untrustworthy readings that make direct access difficult. The similar is the case with the majority of other sensing techniques.

3) Massive Real-Time Data: The design of IoT allows thousands of objects to be connected on a big scale. Massive size of heterogeneous data as constant, high velocity, continuous data flows is the result of communication between a variety of objects in a dynamic network. The competent processing of big data needs expandable storage space, filtering, and compression approaches [9].

4) Implicit Semantics: The quality of unrefined IoT data is low with feeble semantics. To support prominent applications like smart homes and smart medical services, it is essential to extract complicated semantics from a gathering of low-quality data into an incident-based outlook.

C. Concept of Data Management in IoT

In IoT, it is possible to comprehend underlying rational and real-time composition of data management from different viewpoints.

All modules of the IoT data management framework are elaborated as below:

1) Data Collection: A data source discovery mechanism plays an important role in IoT applications which allows the announcement of the application amenities only after the forwarding of responses from the sources. Technological tools with the potential to enable the tap into different data sources include RFID, GPS, NFC, smart phones, actuators [11], and multiple sensors.Since the consistency of existing IoT paradigms is away from real-time use, data cleaning is necessary for implementing and analysing IoT data correctly. The layer is mainly responsiblefor reducing data irregularity.

This can be a daunting task with the availability of the large-scale information, diverse fault origins, and practical processing necessities [12].

2) Data Administration: The traditional strategy to IoT data administration is an interactive database, a document-specific database, or a knowledge driven approach. Implementation of these techniques as middleware storage answers relies on the certain requirements of the deployment. An overview of the procedures for analysing large-scale data warehouses is expressed in the following way:

a) Cleaning Data: This procedure aims at detecting and removing faults and anomalies from the data to enhance the datavalue. In the IoT environment, ground truth data is produced continuously from multiplediverse distributed sources for example, variability of smart goods, people and services. The quality of data from numerous data sources requires effective data cleaning [13].

b) Adaptable Architecture of Database: Data storage in terms of IoT has to cope with a massive volume of data being produced comfortably and continuously. Data stored in IoT is generally recognized as SQL and NoSQL. SQL is employed in interactive models wherein data is arranged in relationships in such a way that a table containing rows and columns represent each data record. Both databases are unlike in the way that that NoSQL don't split info into relationships. Also, they establish communication with the database through SQL.

c) Effective Indexing: Queries are the most typical transactions released to the database [14]. There is the need of trade-off between effectual recovery and scalable index storage to develop indexingmethods to simplify the recovery of huge volume of flowing sensor data. Creating and storing indexes is toomuchcostly, both with regards to capacity and processing. In any case, indexation of dynamic spatiotemporal is a critical stage. Discovery Service (DS) 33 and "Update and Query Efficient Index" (UQE-Index) are amongst the few advances in indexation. HBase enforces them as data repository for parallel processing. DS aims to improve the search efficacy of items in the goods delivery sequence. Its storing scheme adopts the entity identity as the rough key, the episode time-sequence as the column recognizer, and the episode cataloguedata as the cell rate [15]. Centralized indexation depends on a dispersed NoSQL data repository. As far as UQE-index is concerned, it is intended for high insert throughput and capabilities for efficient multiple dimensional queries.

3) Data Processing: There is the need of substantial calculationsto process and analyse data, for example cataloguing and deriving. These operations are deemed as the costliest energy consuming procedure. The various innovations and mechanismsconcerned with this operation often lead to sharing of data between different systems of extremely complicated natures using special ad-hoc protocols.To get a richer view of vital operations executed in this phase, the subsequentpartdefinesimportantmethods to manage data descriptions, connectives, and compatibility.

a) Access Management: IoT implementations depend on big data where SQL is the current benchmark for info access. SQL is typically the main procedure for performing standard select/projection/connection/aggregation processes or snuggled processes for difficult queries. The earlier one primarily represents queries released either to request gather [16] data actually for temporary monitoring objectives or to abstract a specific interpretation of the data saved in the framework.The second one explicitly offers a betteruniversal view of the info and deeper study of tendencies and formats. The two main instances of constructions to lodge new types of accessing info are TinySQL and TrikiDB. Both frameworks process queriesby characterizingsensing devices in the tabular form.The clients can injectquestions at themain hub. These questions are then translated into sensingdevicein comprehensiblearrangement and passed to devices to obtain the outcomes.

b) Query Optimization: The enormous amount of message trade-offs converted into the cost of message sharing has become a core challenge to the IoT landscape as IoT gadgets are often geologically scattered. The lowest-cost data-extraction plan is a common target for the query processing.As a result, query processing is not easy to find the most optimal strategy for retrieving data from different collection devices and returning the resulting total readings.Presently, a new paradigm known as MapReduce occurs forcomprehensive data analysis [17]. MapReduce consist of first-rate characteristics, large adaptivity, and simplified software design etc.

c) Data Aggregation: It contributes as a major platform for routing in ad-hoc networks independent of wired infrastructure.The notion is to unify incoming info from various origins by removing idleness and reducing the sum of communications as minimum as possible. It is an energy-efficient approach and combines the information in the base station. This is deemed as an importantapproach to reduce the communication overhead required to transmit rough stream of data. It aims at collecting the most important data from the sensing devices and ensures the availability of data in an energy saving way with least delay. Network lifespan, data accuracy, and delay are some other crucial gauges of aggregation algorithms. During the aggregation operation, there may be a potential loss of accuracy due to the rejection of the basic comprehensive data. However, specific applications still require data aggregation and fusion.

It is possible to use various radio transmission techniques to transfer the data to the aggregation points.

D) Challenges in IoT Data Management

The more difficulties there are in collecting, processing, administrating of data, the greater will be the growth openings that can fuel the growth of IoT across multiple realms. Following are the difficulties encountered in IoT data management [18]:

1) Technological features of gadgets: A group of technological characteristics typically rely on the implementation taps including sampling rate, transmission. Managing odd band of frequencies and sampling rates of infrastructure or gadgets is not easy at all.

2) Lifetime: IoT gadgets have shorter service period than expected at all times. This disparity

should be taken into essentially during the designing and managing process.

3) Energy: The lack of assets for dynamic gadgets and the intricacy of mixed innovations due to the increase in the knowledge requested from computational algorithms and systems has always been a major constraint of IoT.

4) Data and information: IoT data obtained from variedorigins demand consistent and flexible data management.

5) Human and businesses: Easily usable and reused impermanent devices attached to humans are often ignored.

II. LITERATURE REVIEW

A. Data Management using Efficient Techniques in IoT

M. S. Islam, et.al (2019) emphasized on maintaining the secrecy and integrity of data of IoT (Internet of Things) and managing the hugedata analytics after collectingrepresentative data from numerous IoT gadgetsseparately [19]. A model was put forward forpreserving the data privacy on the basis of TEE (Trusted Execution Environment) includingE2E encoding technique, and sturdy access management's plans. Furthermore, a basic model was developed for simplifying the procedure to collect and gather theheterogeneous data.Moreover,a drone-drivenframework system was practically presented to process rough information. This system offered furtherinsights to implementeffective case for edge and on-device computing.

I. Lujic, et.al (2020) suggested an EDM (Edge Data Management) Frame based on a generic model in order to recover various gaps in imperfect datasets [20]. For this,STR and MTR were deployed in which PRMs(projection recovery maps) were contained. Additionally, an adaptive technique to manage storage was adopted to mitigate thedata stored at the edge in which only crucial data was utilized to accomplish PA (predictive analytic). The experimental results depicted that the suggested approach was useful to lessen the errors around 65.48%using MTR, diminish the volume of stored data up to 39.9%and offered the accuracy of 98.83%.

K. Toyoda, et.al (2019) introduced a different blockchain-based technique in order to manage the sensor data [21]. A concept that the sensor data was periodical and stable at certain level was considered to compress and store a volume of sensor data.A real sensor data was employed to test the introduced technique with regard to CR (compression ratio), time for storing and extracting the data, etc. The results demonstrated the feasibility of the introduced technique for small factory cases.

W. Zeng, et.al (2019) developed methods to manage the data of IoT (Internet of Things) inIoT-Edge-Fog-Cloud environment [22]. The fundamental objective of this approach was to store, specify and discover the data. Initially, a semantic model was constructed to specify the flowingIoT data. The TSDBs (time sequence databases) made the deployment of DS-ontology and the semantic specifications were obtained fordata streams usingSE (semantic-enhanced)-TSDB tool. This resulted in retrieving thesemantic-based data. This tool was considered to build methods of discovering data so that the semantic based data was extracted. The developed methods were assisted in tracking and extracting the data streams in effective manner and enhancing the KD (knowledge discovery).

TABLE I. COMPARISON OF EFFICIENT TECHNIQUES USED FOR DATA MANAGEMENT

Author	Year	Technique Used	Findings
M. S. Islam, et.al	2019	A generic model, Drone-based data processing system	This system offered furtherinsights to implementeffective case for edge and on-device computing.

I. Lujic, et.al	2020	EDM (Edge Data Manageme nt) Frame based on a generic model	The experimental results depicted that the suggested approach was useful to lessen the errors around 65.48%using MTR, diminish the volume of stored data up to 39.9%and offered the accuracy of 98.83%.
K. Toyod a, et.al	2019	Different blockchain -based technique	The results demonstrate d the feasibility of the introduced techniquefor small factory cases.
W. Zeng, et.al	2019	A semantic model, DS-ontology	The developed methods were assisted in tracking and extracting the data streams in effective manner and enhancing theKD (knowledge discovery).

B. Data Management using Compression Techniques in IoT

C. Tsai, et.al (2019) projected a two-layered framework in which the compression method was implemented for alleviating the network traffic [23]. Furthermore,a NoSQL database called MongoDB was executed for storing thecompressed data as this database was scalable and cost-effective. The projected framework was evaluated against diverse techniques in the experimentation. The experimental outcomes exhibited that the projected framework was capable of diminishing the amount of data up to 80%.

K. Hossain, et.al (2018) established a two-layered compression mechanism for IoT data with the purpose of alleviating thevolume of rough info [24].This mechanism maintained a leastER (error rate)and avoided bandwidth wastage [24].Moreover, a lossy compression method was implemented for mining the IoT data in cloud storage. The established mechanism compressed the fog motes at 50% CR (compression ratio) and compressed the data around 90% in the Cloud storage.

M. R. Chowdhury, et.al (2021) investigated a new multivariate scheme to compress data for intelligent metering IoT [25]. Thecross correlation among various variables which the smart meters sensed was considered for mitigating the dimension of data. Afterward, the temporal compression was carried out usingsparsity in each de-correlated stream. The multivariate normal-ARIMA (autoregressive integrated moving average)was employed to characterize themultivariate data prior to compress the data when thecompressed data was reconstructed. Thereal smart metering setup was utilized for testing the investigated system. The results revealed the supremacy of the investigated system over other techniques while transmitting the data.

B. Yuan, et.al (2020) designed a technique for securing the data while transmitting it among the smart city devices of IoT (Internet of Things) [26]. In this technique k-n secret sharing technique was integrated with SDN (software-defined networking) for forwarding the data with security.The SDN controller was utilized compute various routes which were helped in sending the data. The attributes of k-n secret-sharing technique was adopted to ensure the data privacy. The unstable data state was tacked using the designed technique. The experimentation indicated that the designed technique was applicable for diminishing the attack success rate.

TABLE II. COMPARISON OF COMPRESSION TECHNIQUES USED FOR DATA MANAGEMENT

Author	Year	Technique Used	Findings
C. Tsai, et.al	2019	Two-layered framework	The experimental outcomes exhibited that the projected framework was capable of diminishing the amount of data up to 80%.
K. Hossain, et.al	2018	A two-layered compression mechanism	The established mechanism compressed the fog motes at 50% CR (compression ratio) and compressed the data around 90% in the Cloud storage.
M. R. Chowdhury, et.al	2021	New multivariate data compression system	The results revealed the supremacy of the investigated system over other techniques while transmitting the data.
B. Yuan, et.al	2020	k-n secret-sharing technique was integrated with SDN (software-defined networking)	The experimentation indicated that the designed technique was applicable for diminishing the attack success rate.

C. Data Management using General Techniques in IoT

M. Younan, et.al (2021) suggested a new technique in order to alleviateand summarize the data dynamically with the help of DTW (dynamic time warping) [27]. Moreover, a balanced model was put forward to perform the balanced indexing on the basis of similarity data fusion. The predictive models based on reducing the data were assisted in search and secure exploration for SThs (Smart Things).The Szeged-weather data set was utilized to conduct the experiments. The results depicted the effectiveness of the suggested technique for mitigating the data up to 95%, lessening theindexes sizes and expanding the cycle length.

S. Qi, et.al (2021) formulated a Cpds (compressed and private data sharing system) to manage the private data effectively for the product data whose storage was done on the blockchain [28]. Moreover, 2 novel techniques were adopted for storing thetrampled and rule-basedgoods data on the blockchain.This permitted different industrial users to impart item data to viable access regulator in a dispersed scenario. A reliable mediator was not considered in this process. The results indicated that the formulated system was feasible to enhance the efficacy and security to protect thedata saved on the blockchain.

S. Sawalha, et.al (2021) recommended an innovative method forstoring the structured IoT (Internet of Things) data in successful way so that the efficacy to analyze and retrieve the data was improved [29]. The major intend of this method was to pre-process the data for which the data was clustered into diverse levels with no loss of even a single value. The recommended method was quantified on 8 datasets with regard to storing ability and computation duration. The findings proved that the recommended method performed more effectively as compared to other techniques.

TABLE III. COMPARISON OF GENERAL TECHNIQUES USED FOR DATA MANAGEMENT

Author	Year	Technique Used	Findings
M. Younan, et.al	2021	DTW (dynamic time warping)	The results depicted the effectiveness of the suggested technique for mitigating the data up to 95%, lessening theindexes sizes and expanding the cycle length.
S. Qi, et.al	2021	Cpds (compressed and private data sharing system)	The results indicated that the formulated system was feasible to enhance the security to protect the product data storage on the blockchain.
S. Sawalha, et.al	2021	An innovative method	The findings validated that the recommended methodologyoutclassed its rivalry techniques.

III. CONCLUSION

In this paper it is concluded that the IoT has pulled the enough interest of research community from all over the world due to its wide-ranging services. The use of WSNs is quite popular as a core innovation of IoT. WSN-assisted IoT is used for collecting data in the surroundings and detecting certain episodes of importance in the real world. It can bring huge comfort to the lives of people through its applications for example, environment monitoring, warlike track, and medical monitoring. The IoT network has major issue of energy consumption and data management. In this paper, various data management techniques are reviewed in terms of methodology and outcomes. In future, data management scheme needs to be design which can reduce information leakage in the network.

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