CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

Several works have been proposed for the rate control, congestion control methods and data aggregation methods. Different algorithms have been developed over time and thelimitations of the methodologies used to propose this study are explored in thischapter.

2.2 RATE CONTROL SCHEME IN WSN

Due to dense deployment and amount of traffic flow in Wireless Sensor Networks (WSNs),congestion becomes more common phenomenon from simple periodic traffic to unpredictable bursts of messagestriggered by external events. Even for simple network topology and periodic traffic, congestion is a likely event due to dynamically time varying wireless channel condition and contention caused due to interference by concurrent transmissions.

Muhammad Mahbub Alam et.al.,(2007), proposed three methods: upstream source count and buffer based rate control and snoop based MAC level ACK scheme to avoid congestion. The simulation results showed that proposed methods achieved around 80% delivery ratio even under bursty traffic condition.

PictureSidra Aslam et.al.,(2009), presented several strategies such as power-aware protocols, cross-layer optimization, and harvesting technologies used to alleviate power consumption constraint in WSNs.Lalu Liang,Deyun Gao et.al., (2012),proposed queue based congestion detection and a multi stage rate control methods. In order to design a multi-stage rate adjustment mechanism for nodes to adjust their rates based on the congestion status and to distinguish high priority critical traffic from low priority non-critical traffic, it considered only the current queue length but also the queue fluctuation. Throughput, loss priority and delay were then calculated.

Rezaee et.al.,(2014), proposed Healthcare Aware Optimized Congestion Avoidance(HOCA) to avoid congestion in the first step (routing phase) using multipath and Quality of Service (QoS) aware routing. In the cases where congestion cannot be avoided, it was mitigated via an optimized congestion control algorithm. The efficiency of HOCA was evaluated using the OPNET simulator. Simulation results indicated that

HOCA was able to achieve its goals.

Mohamed Amine Kafi et.al.,(2014), depending on the control policy, divided the protocols into resource control vs. traffic control. Traffic control protocols are either reactive or preventive (avoiding). Reactive solutions are classified following the reaction scale, while preventive solutions are split up into buffer limitation vs. interference control.

Kirti Kharb et.al., (2016), analyzed different congestion control protocols that are employed at the transport layer and some of them working at the medium access control layer in wireless sensor networks. Firstly, a brief introduction is given about wireless sensor networks and how congestion occurs in such networks. Secondly, the concept of congestion is discussed. Thirdly, the reason of occurrence of congestion in wireless sensor networks is analyzed. After that, congestion control and why it is needed in the wireless sensor networks is discussed. Then, a brief review of different congestion control and reliable data transport mechanisms are discussed. Finally, a comparative analysis of different protocols is made depending on their performance on various parameters such as traffic direction, energy conservation characteristic, efficiency etc.

Syed Afsar Shah et.al.,(2017) explored mechanismsfor controlling congestion in the WSNs and presented a comparative study. The congestioncontrol schemes are categorizedas centralized with partial congestion control and distributed withdedicated congestion control.This work presenteda comprehensive review on the existing techniques.All the techniques aimed to control congestion as a commontask to extend the network life time by effectively utilizingthe limited available resources.

2.2.1 Rate based Congestion Control Techniques in WSN

Shelke et al., (2017) developed a PacketPriority Intimation (PPI) based congestioncontrol approach to alleviatetraffic congestion in WSN. In this method, the importance ofeach packet was indicated by setting the PPI bit. The main goal was to efficiently andquickly disseminate packets with higher priorities. Assigning the priority that was statedwithin the data packet itself allowed the network congestion to be disregarded. Yet, themean delay is large when the node mobility is increased and the computational cost ishigh.

Swain et.al.,(2017)designeda unique rate controltechnique called Priority Based Fairness Rate Control (PFRC). When there is a mix oftraffic types, a uniform approach to allocating bandwidth does not improve performance.Hence, it has been found that a better chance of avoiding congestion can be achieved byfairlyprioritizingdifferentclassesof trafficusers. But thistechniquesufferedfromlimitedthroughput,slow performance andrestrictedstorage space.

Zhuang et.al., (2018) developed the Congestion-Adaptive Data Collecting (CADC) method to reduce congestion in WSN. Reducing the number of data transferredwhile keeping the calculation error at the sink node within acceptable limits was the keygoal. The K-means clustering algorithm was able to minimize data distortion by loweringthedatatransfer rate and toensuretheaccuracyofthedata,itwasfurtherdevelopedby addingadynamicnetworkandaggregationalgorithms.However,thebandwidthoverhead was substantial due to retransferring the data and the data loss during the pathfailure was notconsidered.

Rezaee et.al.,(2018) created an Active Queue Management (AQM) to calculate thelikelihood of packet loss. To identify network congestion, this strategy combined AQMwith a FuzzyPID controller based on random early identification. As soon as congestionwas detected, the fuzzy controller was sent an implicit congestion warning to slow downtheflowof data but, the average energyuse wasnotsuccessfullylowered.

Sarode et.al., (2018)developed Data Transmission Protocol Based on Priority Approach (DTP-PA) for data transfer at a varying reporting rate in a sink-specified decision time. Packetschedulingbasedonpacketpriority andhopcountare the twoadditional methods that have been developed with networked traffic initially. At first, onlymission-critical data was routed through the hop node. Upon the occurrence of the buffer overflow, themessagewassent.Then,thedecisionintervalwindowwasintroducedasameansof achieving high consistency with the adaptive rate control mechanism. A pricing adjustment was also made based on the buffer's current allocation.Butitdisregards the queuing modelat individual network nodes.

Cuenca Aetal.,(2018) developed theDual-RatePeriodicEvent-TriggeredSampling(PETS)scheme for a Wireless Networked Control Systems (WNCS) with time-varying network-induced delays andpacket disorder. Network utilization (transmissions) was drastically reduced compared tothe conventional Time Triggered Sampling (TTS) paradigm, although the control system performance was not compromised in. Wireless Networked Control Systems (WNCS) was able to achieve andkeep its stability because of Linear Matrix Inequalities (LMIs). This method was moretime consuming.

Srivastava et.al., (2019)created a rate-based congestion control method was depended on cluster routing-dependentto the powerconsumptioninWSN.Thenodeswereinitiallycategorized using a combination of K-means and Greedy best-first search. The fireflyoptimization was then used to implement the rate control method, speeding up the pace atwhich packets were sent. The information was also transmitted via a routing schemeinspiredbytheoptimizationtechniquesusedbyantcolonies.Howit does not considered quickly, there by thetime requiredtodoso it wasconsiderable.

The multi-rate PI controller strategy was developed by Deng et al. (2019) in a digital control system that accepts multiple input rates. The closed-loop input multi-rate digitalcontrol system was initially stabilized using the Lyapunov stability criterion. The Linear Matrix Inequalities (LMI) and the multi-rate PI controller's parameters were computed using the Schur complement.Finally,amulti-ratePIcontrollerwascreatedanditsvaliditydemonstrated.Unfortunately,theresultsfromusingth is techniquewere good and it is not in expected quality.

Swain et.al.,(2019), designed pairofratecontrolalgorithms to combat congestion and keep transmission losses to a minimum.Usingtherate control higher-orderdifferentials, loss is automatically reduced while throughput is maximized. Theconceptof weighted prioritization has only served to strengthen this. The rate control method wascreated toincrease throughput while decreasingdelay andloss,therebypreventingnetworkcongestion.

A better congestion control protocol was createdwiththegoalofreducingdatalossandimprovingQoSperformance by Manjul et al.,(2019).Initially,IP-multicast was employed to transmit the data from its origin to itsfinal resting place.Then, a Distance Vector Multicast Routing Protocol (DVMRP) was used with the webserviceauthorityasthe middleman togetdatafromthe origin tothemulticastdestination. The target then relayed the feedback through unicast in order to confirm theshortest queue delay and deal with the congestion.But,its scalability and fairness suffersignificantlyinlarge-scalenetworks.

DivyaPandey et.al.,(2020) designed various optimization models and future directions for the mechanism of congestion control in the domain of wireless sensor networks.

Wojciech M. Kempaet.al., (2020) proposed a mathematical model of the node of a WSN with discrete time parameter including the probability distribution of the buffer overflow period. The model is governed by a finite-buffer discrete-time queueing system with geometrically distributed interarrival times and general distribution of processing times. The solution of the corresponding system had probability generating functions is found using the analytical approach based on the idea of embedded Markov chain and linear algebra. Corresponding result for next buffer overflow periods was obtained as well.

Noor Zaman1 et.al., (2022)proposed Probabilistic Route Repair Protocol (PRRP) to minimize energy consumed in each node by reducing the total number of time in which a sensor node is in an idle listening state and reducing the average communication distance over the network. The performance of the proposed PRRP was critically evaluated in the context of network lifetime,throughput and energy consumption of the network per individual basis and per data packet basis.

Grover et.al., (2022)proposed novel Rate Aware Congestion Control (RACC) technique to divide network congestion into three types. UserDatagram Protocol (UDP) pressure technique helped RACC to lower its bandwidthneeds, which inturn lowers the number of headers/packets that need to be processed andin turn, the amount of power needed to do so.

Surenther et.al., (2023) proposed Deep Learning based Grouping Model Approach (DL-GMA) that optimizes energy usage in WSN. DL-GMA employed advanced deep learning techniques, particularly Recurrent Neural Network (RNN) with Long Short-Term Memory (LSTM) to enhance energy efficiency through effective cluster formation, Cluster Head (CH) selection and CH maintenance. Evaluation using key metrics like Energy Efficiency (88.7%), Network Stability, Network Scalability, Congestion Level and Quality of Service (QoS) demonstrated theeffectiveness of DL-GMA in energy utilization optimization and overall network performance.

A wide variety ofsensors produces a mixture of heterogeneous traffics with different reliability requirements. N. Priya et al., (2023),focused on high traffic congestion which affects communication and produces latency. The high traffic congestion was controlled bya hop-by-hop approach which was applied in the statically deployed sensor nodes and the optimization was performed at the time of communication.To provide a uninterrupted communicationto the WSN, the proposed approach analyses the occupancy ratio of the buffer and evaluated the downstream node congestion level. The Harmony Search Algorithm (HAS) is consideredfor the design of optimal sensor network with Support Vector Machine (SVM). The experimentalresult showed the effectiveness and feasibility of the Harmony Search Algorithm-SVM environment.

2.2.2 Metrits and Demerits Based on Rate Control Schemes in WSN

WSN is constructed by deploying many sensor nodes which has a limited power supply. Each node will accumulate the data from its nearby nodes and distribute them to each other through transmission channel in their communication range (Akyildiz et al. 2002; Yick et al., 2008). In order to enhance the algorithm developed (Yaghmaee et.al. 2007) to prioritizing different types of traffic is therefore being looked into this approach of rate control takes into account both the rate differential between the source and sink nodes and their respective GPs.

Recently, a technique called Reliable, Efficient, Fair, and Interference-Aware Congestion Con- Control (REFIACC) has been used to maximize throughput in WSNs (Bagaa et al. 2007). Equality in bandwidth consumption among the sensor nodes is the main concern in REFIACC.

The rate control is one of the many ways documented for avoiding congestion. It has been noted that RT traffic has special requirements, including low latency and excellent reliability (Yaghmaee et.al., 2009) present a priority-based rate control technique to handle the discrepancies between the RT data and the NRT data.

It results in high packet service time, high energy depletion and less throughput. So, the congestion in WSNs has become one of the most challenging in earlier data transmission scenarios. It is necessary to identify and regulate congestion in WSNs in order to address this issue and boost the efficiency of data transmission in these networks (Kafi et al. 2014 & Shah et al. 2017).

Both link-level and node-level congestion play a significant role in the performance of WSNs. Congestion at the node level happens when more packets are arriving than the node can handle, resulting in a buffer overflow. As a result, there is significant queuing delay and packet loss. Link-level congestion happens if more than two nodes share the channel at the same time.

One of the most primary tasks to prevent the congestion is controlling the traffic flow through the network. There are a number of protocols developed for this goal and they all share the same core processes of congestion detection, congestion notification and rate adaptation. Priority-based Congestion Control Protocol (PCCP) and Congestion Detection and Avoidance (CDA) (Wam et al (Wang et al. 2007)), Active Queue Management (AQM) (Rezaee et al. 2014), and Fairness Rate Control (FRC) (Brahma et al., 2012) are just some of the most popular classical congestion control techniques.They are contingent upon priority, traffic volume and equitable bandwidth utilization. While progress has been made, congestion issues resulting from the co-existence of RT and NRT packet transmissions continue to be a challenge.

Based on the findings of this study, rate limits are implemented for the sink node, the parent node, and the child node (GPs). To monitor the healthcare system, they have invited a rate-control mechanism based on priority (Yaghmaee et al., 2013). While considering the GP of the node and the relative importance of the various traffic classes, the queue length at the node is ignored in the rate control method. With the proposed Wireless Multimedia Sensor Networks (WMSN) the Congestion Control Protocol (Aghdam et al., 2014) considered node queue lengths (WCCP). A variety of metrics have been used to assess efficiencyofprotocol.When it comes to rate regulation, Brahma et.al.,(2014) offered a method in which congestion control and equitable allocation of bandwidth are handled independently.

In addition, a service-needs-aware, priority-based routing system for WSN congestion control has been devised (2016 Monowar)have used the concept of priority based ratemanagementtoBodySensorNetworks(BSNs) to solve the problems of congestion and hotspot avoidance. Monitoring queue capacities is used to identify bottlenecks, while weighted traffic flows are used to determine traffic intensity and node priority. (Ding et al. 2016) offered a Congestion Control Optimal Routing (CCOR) method, that is built on the connection gradient and the traffic radius.

Because of limitations like low bandwidth and short node lifespan, network traffic must be carefully managed. Due to the scarcity of network resources, it is a technical difficulty to ensure that data is sent through it without interruption. As a result, it is essential under these circumstances to develop an effective rate management approach that may avoid congestion while also increasing a nodes lifespan. A sensor network may need to process Real Time (RT) data alone or in conjunction with Non Real time(NRT) data. Conflicting high-priority RT data with low-priority NRT data presents a challenge. Without proper rate control at individual nodes, the network will become congested due to unauthorized users overloading its limited resources and bandwidth. This calls for an innovative approach to rate control that gives the various traffic class patterns.

In contrast, the differentials at a single node serve as the theoretical foundation for the rate restrictions that have recently emerged (Swain, 2019). as the rate at a node changes, so it will the differential one. Changing the distance between a particular node and the sink node is one way to regulate the flow rate. When applied to the same node, differential rate control and higher-order derivative rate control are equivalent. The expectation is that the higher-level derivative control will deftly handle both the unimportant RT data and the crucial Non-Real Time data. To adjust the total priority, which is based on the GP, a weighting factor is applied, with the GP itself being modified by the priority of the various traffic classes that pass through a specific model which was in two types (Swain, 2019), DDRC: Difference of Differential Rate Control (DDRC) and WPDDRC to avoid the congestion based on priority of the nodes in WSN.

Due to its versatility and competence, it intends to utilize the real data generated by agents via a virtual layer. Therefore, a trustworthy data communication is realized. Based on the group of promising solutions to ensure the sustainability, this type of network is deployed in various appliances like medicinal systems, industrial forecasting, rescue management and so on. Every sensor node encompasses every fundamental module for data transmission and reception (Singh ,Paprzycki, 2020). Even if these nodes have a high data rate, traffic congestion leads to a high data loss, less competence and less consistency.

2.3 Congestion Control Schemes in WSN

Kittaliet.al., (2016) designeda flexible routing approach for WSN congestion management. Congestion time is used to travel from point A to point B without encountering any delays. One important factor in WSN is the time of service, which was used to compute congestion time. However, energy efficiency was not effective.

Mohamedet.al.,(2017)developed Reliable,Efficient,Fair andInterference-AwareCongestion Control (REFIACC) technique to improve throughput whileminimizingnegativeeffectsofcongestionandmaximizingfairness.Bytimingthetransmis sion, this method was able to eliminate interferences while still guaranteeing ahighlevelofbandwidthfairnessacrossallparticipatingnodes.. It allowsthe variation in path enities during the scheduling process has helped to eliminate routedisruption and intervention. The most effective utilization of the available bandwidth hasbeen achieved through the use of linear programming and again, average throughputwas lower andtrafficprioritywasdisregarded.

Mohaisen et.al., (2017)developed a hybrid routing system for VANETs to use incongestedurbanareas(VANET-WSN) which is used to describe the issuesaboutenergy andtransportabilitycompared to other routing protocols, the Hybrid Routing Protocol (EMHR) performedwellintermsof packetdeliveryrate,throughput,latency andpowerconsumption.Congestion and energy use at individual nodes could be decreased by employing digitalMap data and the residual energy ratio as energy-based routing. As a corollary, there maybe a rise in the application of predictive analysis. It was difficult to set up and maintainthese sensors usingthis method.

In order to alleviate traffic congestion, Thrimoorthy et.al., (2017) created a systemdependent on pedestrian activity. As the medium shifts, the sensors locations will shift aswell. Predicting these shifts in order to engage in adaptable communication has beeneffective in alleviating network congestion. Simulation results showed that, in contrast toexistingcongestion controlmethodsfor WSN,it had aresultsinsignificantlylessnetwork congestion. Reduced packet loss and increased throughput were just two ways inwhichcongestionreductionboostednetworkefficiency. Unfortunately,packets were dropped when buffer capacity was insufficient.

Gholipour et.al., (2018) utilized Technique for Order of Preference by Similarity to Ideal Solution(TOPSIS) and the response surface mechanism to createa two-stage congestion method for cognitive networks. Congestion and buffer occupancypercentages in the MAC layer of the node downstream were initially calculated. TheTOPSIS was used by the upstream nodes to rank each neighbor and select the next setof forwardingnodes.In addition,the transferratiowas calibrated with the aid of aresponse surface optimization study. Energy efficiency was low, and the computationalloadwas considerable.

By modifying the distribution, velocity and quantity of mobilenodes,anewmethodforfairness-awarecongestionhandlinginWSNshasbeencreated by Tambe et.al., (2018).Toalleviatethecurrentcongestion,thereportingratewassloweddowntomatch the available buffers at each node. Nonetheless, packet loss was common and the deliveryratewaslow.

When it comes to gathering large amounts of data in WSN, Sonpatk et.al., (2018) proposed an efficient congestion control method using a queueingmodel to assess the level of congestion at a given node. Furthermore, theupstream node best suited to control congestion was chosen at each hop. However, thisservice rate was higher in WSN.

With the goal of relieving congestion in networks where users have access to theinternetatdifferentspeeds,Khanet.al.,(2018) developedaflow-based,multi-ratecongestion control technique. The use of multicasting to broadcast streaming video to alarge set of process in WSN. Since there are many different types of receiversinheterogeneous networks, many different single-rate congestion control techniques havebeen devised. Multi-rate congestion control differs from traditional multicast congestionmanagementinthatmitpermitsthesourcetosenddatatomultiplereceiverssimultaneously, each at a varied rate according to its available bandwidth.This approachprovides an effective method for regulating traffic andmaking themost of availablelinks.

Qu et.al., (2020) created Fuzzy Sliding Mode Congestion Controller (FSMC)which is a novel cross-layer congestion handling framework between the transmission andMedium Access Control (MAC) layers thatincorporates the Signal-to-Noise Ratio

(SINR)of the channel into the TCP design. Then, a hybrid of fuzzy and Sliding Mode Control(SMC) was devised, named FSMC, to manage the queue size in underutilizednodeswhile protecting them from the influence of external unpredictable interferences. On theotherhand,overallnetworkwaslower.

Inordertofacilitatedatatransferatanoptimalratewhileminimizingenergyconsumption, Srivastava et.al., (2020) designed a novel congestion handling technique.This strategy combines cluster routing with rate-based congestion handling to reducenetwork power consumption. To begin, they used a K-means/Greedy best first searchhybrid togroup the nodes intomeaningful categories.Then, the firefly optimizationadjusted the pace so that the proportion of successfully delivered packets was maximized.

Congestion and Computer Program Control (CCPC) is a strategy for WSNs that wascreated by Xiaoetet.al., (2022)using the cloud computing architecture. An algorithmicapproach for detecting clogged nodes was developed and the input rate of the nodes wasmodifiedin accordance with the cloud model.

2.3.1 Merits and Demerits of theVariousCongestionControlTechniques in WSN

Thrimoorthy.N,Tet.al.,(2017) proposed Movement based congestion control mechanismto reduce congestion and the network throughput was boosted. There was a finite amount of storage for packet buffering. Packets were lost when there was insufficient buffer space.M. Gholipour A.T. et.al., (2018) proposed Two-stage Cognitive network congestion. This method was significantly better than other methods where its computational burden was high and energy efficacy was less.

Sagar Bet.al., (2018) proposed Fairness-aware congestion handling which was used to Reduce delay.Packet loss ratio was high.Utkarsh Sonpatki, Sai Krishna Mothku (2018) proposed Data forwarding mechanism to Reduce packet loss and delayservice rate was high.

Tayyab Khan, et.al., (2018)proposed Novel flow control based scheme which was used to received more efficiently data with multicast sessions.It had a high delay. Shaocheng Qu, et.al., (2020) proposed Fuzzy Sliding Mode congestion Controller (FSMC) which had a Lessdelay, less packet loss ratio and higher throughput.Energy efficiency was not effective.

Srivastava,V et.al.,(2020) proposed Novel Congestion Handling which reduced network power consumption.It had a high computational complexity. Xiao et. al., (2022) proposed a cloud model and the Congestion and Computer Program Control (CCPC) Algorithm Strategy. Increased mobility response and better use of network resourceswhen utilizing several tokens, an adjacent discovery rate was ineffective and the computation cost was very high.

2.4Data Aggregation method in WSN

Zhang et.al., (2018) developed a unique data aggregation approach based on fuzzy rules and rings to increase energy efficiency while guaranteeing request transmission dependability. To achieve effective data aggregation, a fuzzy logic system was created to infer the variable number of transmitting packet copies. It was adaptively adjusted based on the nodes' distance from the sink and the request network transmission reliability.

Movva et al., (2018) developed a novel RP-MAC protocol for energy efficient WSN with mobile sink node. Clustering phase was initiated by a Weighted Voronoi diagram (WVD) algorithm by assigning weight value for each node. Energy consumption due to idle listening is minimized by enabling novel ring partitioned based MAC scheduling (RP-MAC) in each cluster.

The RPMAC protocol achieved collision-free data transmission in the network. Two-fold data aggregation (TFDA) scheme was developed for data aggregation phase to minimize energy consumption by reducing number of transmissions. Routing phase supports both intra-cluster routing and inter-cluster routing for intra-cluster routing, hybrid chicken swarm optimization (HCSO) algorithm was developed. For inter-cluster routing, position based routing tree (PRT) was constructed based on position of sink node.

Sert et.al., (2018) developed a Two-Tier Distributed Fuzzy Logic Based Protocol (TTDFP) to extend the life span of multi-hop WSNs by taking the efficiency of clustering and routing phases in WSN. The developed protocol, TTDFP was a distribution adaptive protocol that runs and scales efficiently for sensor network applications. Additionally, along with the two-tier fuzzy logic based protocol, an optimization framework to tune the parameters was used in the fuzzy clustering tier in order to optimize the performance of a given WSN.

Jasim et.al., (2019) developed a Secure and Energy-Efficient Data Aggregation (SEEDA) protocol which was secure and energy-efficient data aggregation for WSN using an access control model. The proposed protocol enhances the authentication of MAC by generating a random value and random timestamp with a secret key. The base station node verifies the fake aggregated data before sending it to the server. Other than that, the proposed protocol detects and prevents attacks such as Sybil and sinkhole. The base station nodes also utilize the distance and timestamp between nodes to avoid delay in the network.

Dao et.al., (2020) developed a new scheme of collecting data classification for aggregating data in cluster heads (CHs) in WSN based on improving the classifier of the Support vector machine (SVM). Flower pollination algorithm (FPA) was developed to new version for the optimize parameters for the classification SVM. Due to the requirement of the precise data in several successful WSN applications, a decision function of classification should be deployed in CHs for identifying information correctly to aggregate the usual data for the next process.

Tanushree et.al., (2020) developed cluster based data aggregation with multiple sink which reduces the redundancy and improved energy efficiency. The Virtual Cluster Head (VCH) was chosen due to the importance of the CH and to improve the fault tolerance of the CH. The VCH administrates the performance of the CH and it keeps the copy of data. The efficient data aggregation with fault tolerance strategy using clustering for data transmission across multiple sinks shows improved performance.

Devi et.al., (2020) developed a Cluster based Data Aggregation Scheme for Latency and Packet Loss Reduction in WSN. The processing of this scheme was divided into two phases: Aggregation Tree Construction phase and Slot scheduling algorithm. In the Aggregation Tree Construction phase, the data packets received from the cluster members was aggregated by the cluster head using compressive aggregation function.

The Base Station created a Minimum Spanning Tree (MST) based on every cluster information and schedules the data transmission time for each cluster head. In the slot scheduling algorithm, the cluster head classifies its aggregated data into high and low priority data. The high priority data was assigned time slot on a prioritized basis, whereas the low priority data enqueued and were allotted timeslots after serving the high priority data. But, the energy usage of the nodes was limited.

Kumar et.al., (2020) developed a real time energy efficient algorithm which was not taken a part in the previous cycle. Then for each sensor nodes from the set, the method estimates the Data Aggregation and Fusion Efficiency(DAS), Network Throughput and Scalability(NTS)and Network Lifetime and Stability(NLS) measures. Using the measures specified, the method computes the data aggregation support measure. Based on the data aggregation support measure, a set of sensor nodes has been selected for data aggregation. For the selected nodes, the method identifies the list of intermediate nodes and measures the same. The battery that powers the sensor nodes has a finite number of power.

Daniel Da et.al.,(2021) developed a design of trust based data aggregation protocol using data validation and integrity verification in WSN. In this protocol, the sensed data was encrypted by using shared symmetric key. Then the encrypted data after fragmentation were signed with homomorphic MAC tag. Once the signed blocks were received, the aggregator performs SUM aggregation function after checking the correctness of data and verifying integrity of each block. But, By varying the number of nodes deployed, the average packet delivery ratio, energy consumption, delay and packet drop may be measured.

Yun et.al., (2021) developed a Q-learning-based data aggregation-aware energy-efficient routing (Q-DAEER) algorithm. To calculate the best path to maximize the lifetime and minimize energy consumption of the network, defined a reward policy that considered the energy level, distance, hop count and the degree of data aggregation at each node. For efficient data aggregation at each node with different sensor types, developed a data aggregation and system model in which sensor-type-dependent queue management and transmission schedule control were used. A data-type-dependent action selection and Q-table updating algorithm were integrated into the Q-DAEER algorithm. They constructed three distinct data aggregation models and demonstrated the proposed algorithm's applicability to a range of data aggregation scenarios.

Jagan G &Jayarin et.al.,(2022) developed a Novel Machine Language-Driven Data Aggregation Approach to Predict Data Redundancy (MLDPDR) in IoT-Connected WSN. In this model, energy minimization was carried out in two stages such as data prediction and statistical prediction modelling. Data prediction was performed on IoT network to predict future data coming from all live nodes. A given IoT network contains a sensing node known as aggregator to collect data and broadcast it to remaining nodes. The aggregator node sends only the required number of data instead of sending all received data after processing it using suitable data precipitation techniques. Besides, a sufficient data reduction was achieved during the second phase using a statistical data prediction model to identify neighboring nodes which periodically generate data.

2.4.1 Merits and Demerits Based on Data Aggregation Schemes

Dao et.al., (2020) proposed Flower pollination algorithm (IFPA) and this method produced unlimited power then it reduced energy and decreased use of predictive applications.Tanushree Met.al.,(2020) proposed Cluster based data aggregation method which is used to reduced the redundancy and improved energy efficiency.It had a Limited processing time. Seedha Devi et.al.,(2020) proposed Cluster based Data Aggregation Scheme for Latency which is used to reduced the complexity overhead and end to-end delay.The energy usage of the nodes was limited.

Anita Daniel Da et.al., (2021) developed data aggregation protocol which is used to improved accuracy of the data.The power available from the battery to power the sensor nodes is limited.Jagan &Jayarin et.al., (2022) developed machine learning and IoT network to achieve better prediction accuracy with considerable reduction time in the number of computations.