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An Exploration of Current Data Agglomeration Technique in Wireless Sensor Network

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Abstract— ***Wireless sensor network plays prominently in various applications of the emerging advanced wireless technology such as smart homes, Commercial, defence sector and modern agriculture for effective communication. There are many issues and challenges involved during the communication process. Energy conservation is the major challenging matter and fascinates issue among the researchers. The reason for that, Wireless sensor network has 'n' number of sensor nodes to identify and recognize the data and send that data to the base station or sink through either directly or intermediate node. These nodes with poor energy create intricacy on the data rate or flow and substantially affect the lifespan of a wireless sensor network. To decrease energy utilization the sensor node has to neglect unnecessary received data from the neighbouring nodes prior to send the optimum data to the sink or another device. When a specific target is held in a particular sector, it can be identified by many sensors. To rectify such process this paper present Data agglomeration technique is one of the persuasive techniques in the neglecting unnecessary data and of improves energy efficiency and also it increases the lifetime of WSNs. The efficacious data aggregation paradigm can also decrease traffic in the network. This paper discussed various data agglomeration technique for efficient energy in WSN.***

Index Terms— ***Data Agglomeration, Clustering, energy-efficient, routing.***

I. INTRODUCTION

A Wireless sensor network is a network connecting devices such as sensors, routers and base stations without cables. Among these sensors takes a major place in this field to monitor and gather data from the physical or surrounding environmental condition like humidity, temperature, health monitoring, target tracking, surveillance, wind direction and speed, power-line voltage, vibrations intensity, pressure, sound, motion, pollutants and seismic events etc (1-4). Wireless sensor network contains n number of collections of wireless sensor nodes. These collections of wireless sensor nodes are having limited energy to collects, analysis and transmit their data through the network to a sink or base station. The sink plays as intrude between network and the user. Sensor nodes are small, lightweight and portable. Sensor nodes are intercommunicating with each other using the radio signals. Every sensor node haves four components. First, a transducer to generate electric signals based on sensed data. Second, microcomputers used to process and saves the output of the sensor. Third, the transceiver gets data from the server and sends the data to the computer. Finally, the energy source from the battery is the main thing (5). If a sensor node stopped it's working due to low energy it will lead to big problem and serious protocol failure (6). It is impossible to recharge the battery while nodes are deploying in a belligerent environment. So to meet the need for these types of events sensor nodes should have enough energy and prolonged lifetime (7). So it's limpid that the energy factor is the major challenge for the system set up in a wireless sensor network.

To challenging this issue, the data aggregation techniques are used to decrease the amount of data sent and improves network lifespan in a wireless sensor network. The wireless sensor network consists of more number of sensors. They are usually dispersed in approximate locations. Fewer of them are human intervention. Dispersed Sensors gather the data and send it to the sink. Securing energy is one of the main factors of this network. Sensors use more energy when sending data by the transmitter. Therefore, by combining the data with the middle sensors through network and data compression is essential to manage packets Network (8). The efficient energy effects in sensors, Increase lifespan of the network and bandwidth efficiency.

For that, data agglomeration is called useful technique for integrating data. Data agglomerations carry out the process of gathering data from many sensors. Another contributing factor that affects data agglomeration is the most important data delivery that can be used efficiently with diminutive data delay. So in order to increase the life span of the sensors, various data agglomeration algorithms that are data aggregation are prepared previously under the terms. Data aggregation in wireless sensor network (WSN) is a very important process, because, different types of data are collected from various sources. It requires high energy to transmit the collected data. In order to reduce such energy consumption, data must be collected and analyzed before sending that data. So that we can able to transmits properly combined and concise data with minimal energy consumption (9). Proficient data aggregators are afford energy consumption and also eliminate unnecessary data and afford only beneficial data. Thus, by using the data agglomeration technique can save the consumption of energy during long-range transmission over wireless sensor networks. Figure 1 Illustrate the overall structure of data agglomeration in wireless sensor networks.

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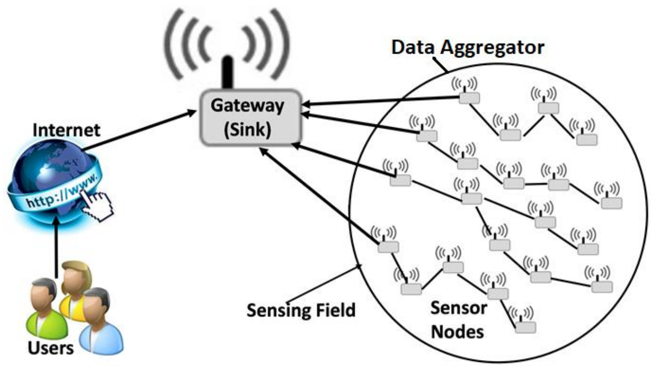

Fig.1. The General Structure of Data agglomeration in WSN.

Major intricacy with data agglomeration is the various types of data within the network. For example, data may be pictures, sounds, video and other sensors data. Therefore, the necessity for modeling the data and concise the data are addressed here. Due to the network size and the more number of nodes in same space, wireless sensor data leads to greater credibility, but on the another side, data stated by the neighbouring nodes has led to more surplus. Therefore, transmitting the data individually by every node leads to energy consumption and increase in the bandwidth the entire sensor network, directs to diminish lifetime of the network (10). Hence, introduced data agglomeration techniques are used to forestall this intricacy. Neglecting the unwanted surplus data transfer, improve lifetime and energy, remit both traffic and data convergence within the network are the goal of data agglomeration techniques.

Here, the need for data agglomeration is described here to make it easier to understand in real time:

The platform such as either Ad-Hoc, IoT or upcoming IoE is increasing the efficacious production in industries, supervising and handling individuals health in the society, ceaseless up to date information from society such as temperature, humidity, weather and car park places, etc. This platform combines and aggregates useful data and develops general codes so that the data can communicate with one another between various equipments and their real time usage and can be transmitted. Every equipment has a processor that processes data safely after being processed locally. The platforms get data from different equipments and distribute their data with their special applications. Device battery energy must be consumed for these data transmissions between user and enterprise devices (11). For this purpose, the combined data minimizes the energy consumption and the number of data transceiver.

A data with and without aggregation in the wireless sensor network is shown in fig 5. Communication between consumer nodes is expensive. So the data collection techniques are developed to cut back the dimensions of excess data and improve the lifetime of the network.

The following upcoming divisions are framed. Part 2 is related work related to literature, Part 3 provides Model of the system, Part 4 gives Performance and Analysis and Conclusion section in Part 5.

II. RELATED WORK

Data aggregation is the process of gathering data and presenting it in a concise format for purposes such as statistical analysis. Data can be collected from multiple data sources to briefly link these data sources to data analysis. This is an important stage because the accuracy of data analytics insights rely on both the numerous data and worth full of the data used. It is important to collect high-quality, accurate data and large enough to produce appropriate results (12). Data collection is a significant function of the wireless sensor network, which reduces the consumption of energy of the sensor nodes, thereby improving the lifetime of the network.

Data aggregation can be useful for all the applications for their operation (13). Through data aggregation and statistical analysis, you will find all kinds of information about the data you are looking for. So the data agglomeration is the process of gathering, analyzing and summarizing the sensor data using various aggregation approaches. It aggregates the sensor nodes information by using various aggregation algorithms. This agglomerated information is send to the base station via choosing the best route (14).

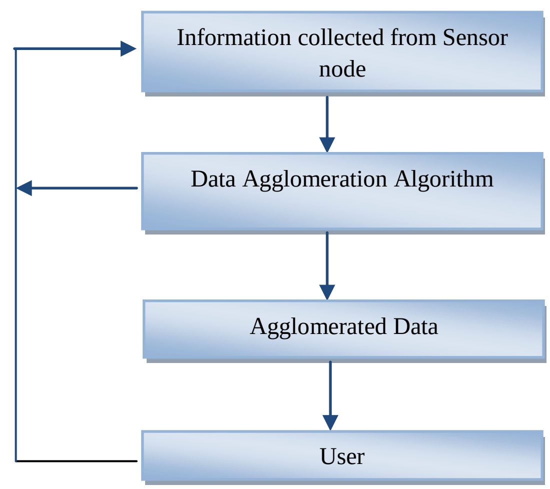

Fig.2. Architecture of Data Aggregation

Different kinds of methodologies are deploying for data agglomeration such as centralized, in-network aggregation, tree-based approach and cluster-based approach as shown in Fig.3.

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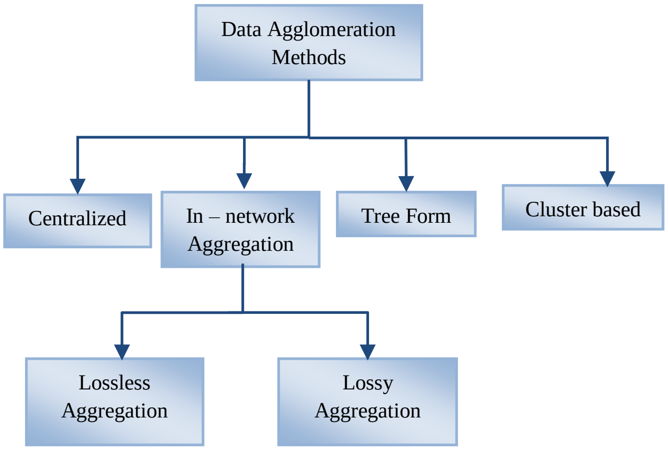

Fig.3. Methods of Data Agglomeration

A. Centralized Approach

In this method, each sensor nodes send its observed data to the central node, which is usually the most powerful node (based on resources such as energy, bandwidth). Address central routing is used with the multi-hop algorithm considering the cost metric for each intervening node. The middle node's work is to consolidate data from other nodes and report the same data to the base station. This approach results in a high traffic volume as large numbers of messages are sent (15).

In this mechanism, each sensor transmits their observed data to a middle node through the simplest route. Every sensor sends their sensed data packets to a node, which is energized between all other nodes. This energized node called as header node. This header node effectuates all the aggregated information by all the sensor nodes into a single packet (16).

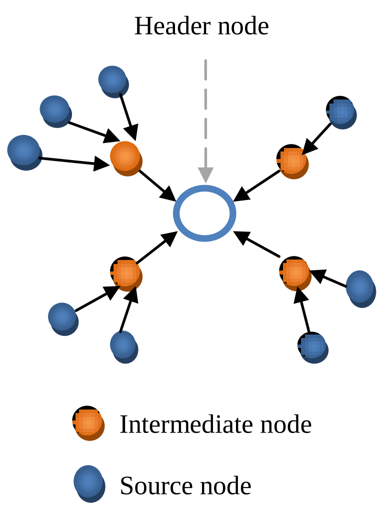

Fig.4. Centralized data aggregation

B. In-Network Aggregation

This method allude, the sending of sensor measurements is the main energy-consuming activities in the wireless sensor networks. In earlier, the RC5 cryptosystem and the CBC-Mac algorithm are implemented to determine utilization of energy caused by calculating and communication process. The utilization of energy by the processor command is omitted one then energy utilization of the radio frequency functions. Therefore, this type of method is used to decrease unnecessary congestion in traffic and to protect limited bandwidth and energy (17). Network data aggregation has three main products, namely routing paradigm, aggregation process, and depicted data techniques (18). Data is operated at intervened nodes to minimize the utilization of important sources such as energy and computational time. This method maximizes lifetime of the network while attempting to minimize utilization of energy on each node.

In this process two other methods to network aggregation: lossless aggregation with packet size reduction and lossless data aggregation without minimum packet size. In a loss aggregation, data is collected from different source nodes and then functionality is used such as sum, count, ma and minimum. After compression, in this method, the packet size is reduced because only the calculated value of the overall operation is added into the packet, rather than sending the entire packet of each node. For example, in a forest fire monitoring system, the average or maximum temperature reading is needed in particular time. In such applications, loss aggregation is required because it responds timely into the base station. In lossless aggregation, each packet is enclosed in a single packet without compression (15,19). The diagram for with aggregation and without aggregation is given in fig.6 for comparison of aggregation method.

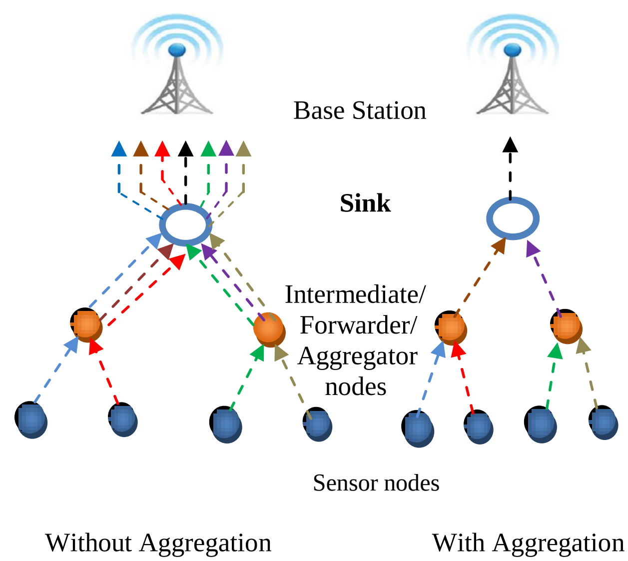

Fig.5. In-Network data aggregation

C. Tree Form Approach

This method allude, a minimum spanning aggregation tree set up is made. This tree has root node, leaf node and parent node. Base station act as a root node, source node act as a leaf node and the parent nodes depicts intervene node.

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The source node sends the observed data to the intervene node via path of source node and the root node. This means that each and every node are formed tree-shaped, like hierarchical, and then with the assistance of the intermediate node, it is able to achieve data aggregation method and send the data from leaf node to the root node (15, 20).

This kind of aggregation method is suitable to the applications that include interworking data aggregation. Radiation-level monitoring at a nuclear power plant is an example application where higher value gives the more effective data for the secure plant. The main feature of this method is to build the efficient energy data-gathering tree.

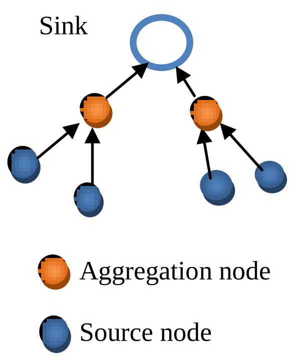

Fig.6. Tree Based aggregation

D. Cluster-Based Approach

Wireless sensor network contains n number of sensors. Those sensors are split and formed a group. The group of sensors is called a cluster. Likewise, it is divided into a number of clusters. In a clustered wireless sensor network, sensor nodes are check and send the data among themselves about their energy level. In sensors who have maximum energy than the remaining sensor nodes for a particular time it will act as cluster head.

Every cluster has a cluster head (CH). CH's periodically collect, aggregate the data from the neighbouring node. The duties of neighbouring nodes sense the data and report into CH only instead of transmitting that information straightly to the sink. After that CH agglomerate every data and forward to sink or base station. Currently, various clustering technique are revealed to frame a sensor network into one set. Thus the utilization of energy is dispersed across all sensor nodes. (21-23)

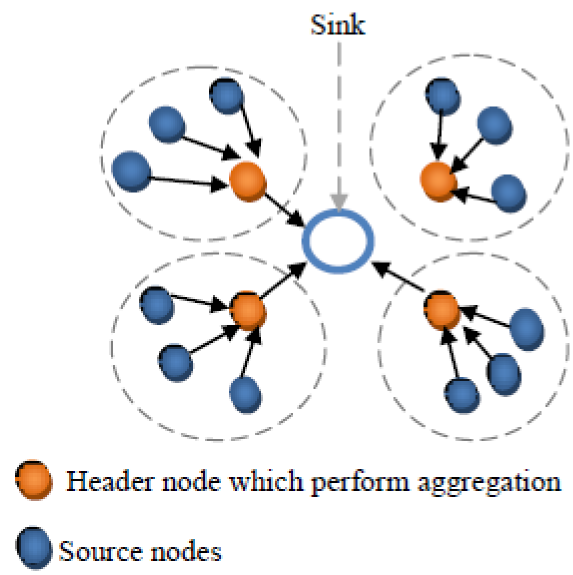

Fig.7. Cluster based data aggregation

Data Agglomeration Techniques

By using above methods various data agglomeration technique is playing a prominent role in aggregating worthwhile tidings in wireless sensor network. The more number of data agglomeration algorithms have been proposed from 2002 to until present. This technique presents currently five techniques deployed in novel data agglomeration process.

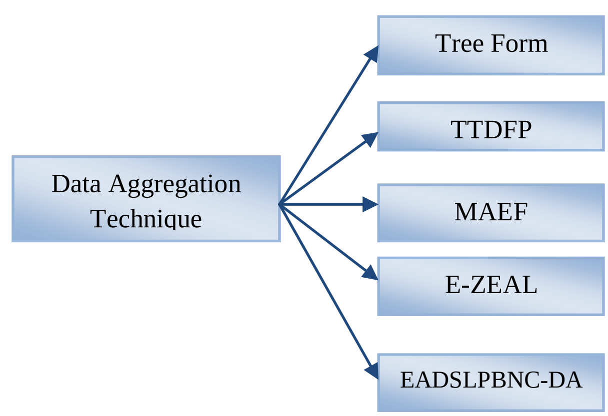

Fig.8. Data aggregation technique

A. Tree-formed data aggregation approach in wireless sensor network using fitting functions

This technique presents currently five techniques deployed in novel Data aggregation process. This technique applied data agglomeration by bi-node based. This author employed on transmitting less data from the data collector to the base station and then this technique used Bayesian belief network algorithm to determine the accuracy. Due to low levels of energy, less processing skills, limited communication and lesser memory size wireless sensor network are restrained in resources.

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In view of this, this technique aims to surpass these challenges by developing protocols, techniques, innovative methods, and adopting research trend is a service which is a data aggregation aimed at overcoming barriers in memory storage like retention the storage space and energy. Anyhow, this technique aims to reduce energy consumption by diminishing the data size that needs to send. In the sensor field, usually, the sensor nodes execute tri function: 1. identify and execute events, 2. Rapid data processing and sending information to the target. Data compression technique is important in WSN. Because, there are three stages of function for utilizing energy in wireless sensor networks: 1. Sensing, 2. Communication and 3. Execute stage. The energy utilization within the communication stage is critical for the both transmitter and receiver to try to do its work. Hence, the quantity of power used in the transmission of information is way on top of that employed in data computation.

This method depicts energy is one of the most prominent hindrance in wireless sensor network because commonly, there is a depletion of energy in all sensor batteries such as depletion in energy can lead to improper latency in critical use (24). This technique concentrates on to reduce the energy utilization in the network. For that purpose, two approaches have been used in this effective data collection technique namely, filtering approach and the matching approach.

(1) Filtering Approach

To eliminate similar data filtering approach is used. That is finished by contrasting the standard of their distinction and that of a predefined edge. In the event that the determined standard is not as much as this limit, at that point the new information measure won't be transmitted by the primary level.

At the aggregation level, comparable informational collections have more prominent closeness than a given limit, in which similitude can be determined utilizing numerous techniques. One of them is the Jacquard similarity implies another cover work dependent on the closeness work previously referenced.

The following equation for overlap function is,

$$O\ (N1, N2) = |N1 \cap N2| \geq t$$

The following equation for Jaccard similarity converted to convergence:

$$J\ (N1, N2) = \frac{|N1 \cap N2|}{|N1 \cup N2|} \geq t$$

$$O\ (N1, N2) \geq \frac{t}{t+1}\left(|N1| + |N2|\right)$$

This is complex when contrasting all the n informational collections originating from n distinctive sensor hubs to one another. The researcher followed past works and it is discovered that on the off chance that the sets were requested from regular to less successive, at that point the important condition to demonstrate the presence of similitude was that their first components must be indistinguishable. In this work, the Analyst includes different measurements. In this manner, rather than taking a shot at just a single parameter which is temperature, this technique chipped away at three parameters whereby their mix is a record or vector.

Here 'I' is the vector made out of three parameters given below,

$I = (x, y, z)$. The new prefix filtering rule is:

$$\sum_0^i \sum_0^j (link\ Ii\ , Ij) \geq \frac{t}{t+1}\left(|N1| + |N2|\right)$$

The computational issue must be low in light of the fact that subsequent enduring non-comparative sets are as yet quadratic. This thought is utilized to limit the quantity of correlations between sets.

(2) Fitting Functions

The motto of this technique is to send fewer information parameters with the fitting function relating all parameters since, fitting capacities can without much of a stretch be put away in a sensor node, in spite of their constrained storage place (25). Along this way, the neglected parameters during the information move from the aggregator to the sink can be recalculated at a later stage utilizing the fitting capacity. To approve this thought, two investigations are used. The first think about just two parameters such as humidity and temperature and second trial three parameters such as humidity, temperature and voltage are thought of. Both confinement agglomeration algorithms and prefix fitting are used to the vectors. From that point onward, the information cleaning process is used to the amassed information to evacuate anomalies, which are the sensor information errors in every parameter.

The improvement level attains 15% by using data cleaning method for optimum solution in the fitting function. The non-linear fitting method is the best interpretation of the data by evaluating the function parameters. To evaluate that method by simulating in OriginPro software, it is a own computer program for synergetic technical graphing and testing the information. This methodology used to transmit only a portion of the information along with the calculation that revel all criterions and rest portion of the information will be evaluated at the base. Through this less transmission of data, it preserves energy. Nonlinear least-squares fitter method used to perform the Origin's curve fitting and helps the Levenberg-Marquardt algorithm. In this method error is calculated and evaluate the result by the function is expressed as,

$$Y\ (error) = X\ (expected) – X\ (actual)$$

This method plot the result of Y (error) in the graph shows closest value of zero. The system model and performance results of this technique will see in upcoming sections.

B. Two Tier Distributed fuzzy logic

This technique aims to prolong the lifetime of multi-hop wireless sensor networks. For that, this method the both clustering efficiency and selecting best routing part considered into the account. This technique productively quantifies sensor network applications.

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Furthermore, it utilized an advancement system to adjust the criteria used in the fuzzy clustering layer by two-layer fuzzy rationale based algorithms to develop the presentation of a given WSN (26). This technique additionally incorporates execution examinations and exploratory assessments with the chose cutting edge algorithms.

There is no other required related information, such as a node's location or connection that is used as input criterion in the grouping progress. Thus, last groups cannot meet the normal execution prerequisites. What's more, hotspots or vitality opening issues can emerge in WSNs in light of the fact that the situation of every hub is not considered. The Hotspots issue is identified with the troublesome demise of pioneers who is near to the sink device or on occupied paths because of a serious inter-cluster relay. These solutions are available only for mastering clustering and routing phase to prolong the life of WSNs and should seek a effective energy activity in multi-hop situations. Something else, the vast majority of the energy spared from grouping will be more prominent in the steering stage. This circumstance can likewise overbalance the energy circulation of the system, which negatively affects grouping. So it is not enough to use a multi-hop routing system as an alternative to direct communication. Thus, the intensity of fuzzy logic was exploited in the steering stage over its comparing to that of another part.

This technique is to address the issues of data aggregation in multi-hop wireless sensor networks. This technique has two tiers. In tier 1, this method settles on the last clustering head through energy based rivalry of temporary pioneers, which are essentially picked by methods for a probabilistic model. Protocols of this method consider the lifetime necessities of the wireless sensor networks. This protocol no need to incorporate a focal choice point in any of its stages. This dispersed activity design shields the convention from the single-purpose of-disappointment circumstances.

This technique handles more vulnerability in grouping occasions than its smooth and other fluffy partners. This procedure proposed the proficiency of grouping and directing stages mutually into account instead of taking a gander at clustering which has efficient energy and use the enhancement structure (27) to adjust the two criterion in this level, which are the most extreme rivalry range and edge, as opposed to utilizing an experimentation way to deal with locate the correct mix of these criterion. To tune the previously mentioned set of criterion with the point of upgrading the presentation measurements of the wireless sensor networks enhancement structure utilizes the simulated annealing (SA) algorithms were utilized. What's more, the equivocalness in the Subsequent tier 2 improves the steering execution contrasted with its smooth partner. Considering these commitments this procedure recommended that TTDFP approach utilized in strategic genuine applications where usage setting might be refreshed concerning the application space.

In the grouping stage, this fuzzy logic method has attempted three fluffy parameters. There are kin node availability, separation to the sink device and leftover node energy. In the steering stage, this fluffy protocol loads the operational design of the known multi-hop directing framework utilizing fluffy logic. In this subsequent level, this method uses two fluffy criterion, namely average link residual energy (ALRE) and relative distance (RD) to decide a proficient directing way. So as to quantify the competency of the arrangement, it is tentatively assessed against a chosen particular arrangement of the previous grouping algorithms, for example, LEACH, CHEF, EEUC and MOFCA. Several experiments are conducted under various operating conditions. This TTDFP model is to prolong the system lifetime. Be that as it may, the measure of time taken for gathering the information was more. Execution results exhibit that TTDFP method will see in forthcoming areas.

C. A multi-mobile agent itinerary planning-based energy and fault aware data aggregation (MAEF).

This technique is used to design a way for mobile agent nodes and it is another tool for customer/server prototype. This mobile agent relocates to the sensor nodes (SNs) to gather information, rather than sending the information assembled by every node to the sink as in customer/server, subsequently lessening energy utilization and transfer speed use. For mobile agents, to relocate among sensor nodes, a route ought to be arranged before the movement. A few methodologies proclaimed to take care of the issue of steering that is routing strategy for mobile agents, yet these methodologies depend on the suspicion that mobile agent nodes see whole sensor nodes. This supposition is wasteful because of the expanding size of the MAs subsequent to visiting every node. In the event that the nodes come up short, which is frequently the situation in wireless sensor networks, mobile agent cannot relocate into sensor nodes. So this technique is to design a way for mobile agent. This can be accomplished by gathering nodes in the cluster and arranging the ways productively among group heads that is cluster head as it were. In addition, an optional way is arranged if there should be an occurrence of node wreck (28).

In WSNs, generally handled processing prototype is the client-server (CS) prototype, in that every sensor node reports their gathered information to the base station by the route of multi-hop path (29). Yet this customary prototype experiences huge shortcomings things like that the network size is not being scalable. Furthermore, the measure of information that should be handled in the sink is enormously expanded, which restrains the capacity of remote availability to be kept up at the least data transfer capacity of remote network utilized in wireless sensor network. In recent years, and a productive prototype has risen and has been embraced by specialists as another to the standard client-server prototype, called the mobile agent prototype (30). In this prototype, mobile code moves to sensor nodes to gather information, rather than being sent to the base station by sensor nodes, as in customary CS (31). Mobile agent is a specific sort of Programming Organization that moves to sensor node for gather information.

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Compared to the CS prototype, the MA was significantly lower than that of the CS. The prototype has many features that make it very relevant for WSNs. It should be noted that travel arrangement to mobile agent is a very confronting intricacy. Performance oriented data agglomeration of mobile agent rely in travel planning. The path that MMA follows when migrating to SNs is a journey. Planning a trip to MA has proven to be an NP-difficult issue and it is the major confronting problems with this prototype.

Hence, there are three points to arrange a route for mobile agent:

- In clustering, a number of Sensor Nodes that ought to be called on by every mobile agent.
- The Route arrangement for mobile agent alludes to the request wherein these Sensor nodes ought to be called on by the mobile agent.
- The quantity of MAs is the quantity of MAs to be dispersed to gather information.

Route arrangement for mobile agents are may be active or inactive. In Sustainable routing arrangements, mobile agent travel is figured at the sink level and afterward mobile agent. In light of the pre calculated travel schedule of the sink, it migrates to the sensor node. Dynamic Travel Planning (DIP) is the way to mobile agent to rapidly choose the following receiver node to fly. Sustainable methods is the best suited to tracking applications in which the information collected is revert to the base station. Then again, inactive methodologies are frequently utilized in the following applications and because of the idea of the falling flat wireless sensor networks (32), the failure of the node (s) to plan the MAs without considering the wrong nodes (FNs) can cause problems. MA may prevent subsequent migration between SNAs. So in the technique, notwithstanding the way toward arranging route gets ready for mobile agent in cluster head, it proposes adaptation to non-critical failure that is fault tolerance dependent on elective route arranging in case of a first trip wreck.

This method follows different steps are:

- Group formation
- Route arrangement surrounded by cluster head
- Relocating mobile agent
- non-critical failure depends on elective route arrange
- This method comparing with the existing method by Castalia simulator.

So this technique proposes to plan mobile agent for mobile agent surrounded by cluster head and then design an elective travel plans if the first fails. Clustering method is used to group SNs in clusters and uses one clustering per cluster for data aggregation. It selects and then plans the trips only on CHs using the least wide tree. System model and performance of this method discussed in the next section.

D. An enhanced Zone-based Energy-Aware Data collection (E-ZEAL) routing protocol

This technique aims to improve the performance of energy conservation and data transmission in wireless sensor network. K-means clustering algorithm is used here to locate the simplest way for the portable sink node and furthermore it gives better determinations to sub sink nodes. The investigations are assessed by the ns-3 software tool.

The execution of E-ZEAL is contrasted with above ZEAL. The primary difficulties in wireless sensor network are sparing the energy utilization of sensor nodes because of the fewer lifetimes of sensor nodes. This method attempts setup phase time and the duty cycle algorithm is to preserve energy by diminishing the wake time of the part nodes. In any case, ZEAL doesn't deal with the format of the portable sink way, despite the fact that the mobile sink way influences wireless sensor network execution as far as energy utilization and information conveyance (33). For instance, the briefest way builds the number of hops for correspondence, devours more energy, and lessens information conveyance, yet additionally decreases information assortment time. Then again, the long way, draws nearer to the part nodes, diminishes the number of hops for correspondence, energy preserves, and improves information conveyance, yet in addition increments.

Energy doesn't deal with the design of the mobile sink way. So the test is to locate the ideal way that can adjust between all criterions. In this specific circumstance, this technique is used to improve wireless sensor network execution as far as energy utilization and information conveyance (34). This algorithm has three stages (Information assortment stage, Pre-handling stage and Arrangement stage). The Information assortment stage and Pre-handling stage subtleties and the adjustments to the arrangement stage are talked about in the accompanying sub-areas.

(1) Information assortment stage

In this stage according to survey it is the data collection phase. In this phase sensor node transmits the aggregated information to the sub sink node and this sink node conveys that information to the mobile sink node as shown at fig 9. Each member node calculates and selects the highest Priority (Pr) for all sub-sink nodes within the same zone. The data aggregation process is conducted each routine are; every sub sink nodes receives POLL1 information from mobile sink. Further, that mobile sink receives the data packets from the sub sink nodes within the allotted time slot ends or number of data packets decreases.

(2) Pre-handling stage

In the stage is for seeks out the ideal way for the mobile sink. The ideal way is characterized as the way which accomplishes the base number of hops and the base separation for the gathering of the part nodes and sub sink nodes. So to locate the ideal way like the plan proposed in the survey (35). Some protocols are incorporated in this pre handling stage of the EZEAL technique.

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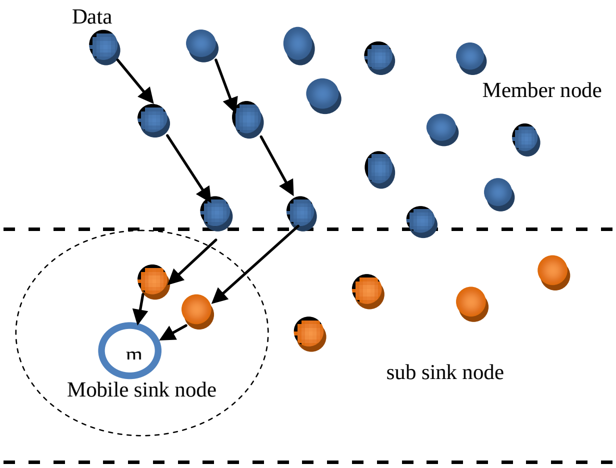

Fig.9. Data collection phase

(3) Arrangement stage

This stage is similar to the setup phase. E-ZEAL in the setup phase is indistinguishable to the primary elements of ZEAL in the arrangement stage. In this paper changes the needed condition to give a superior choice to sub-sink hubs. This method was presented in (36) to show signs of improvement energy use and information conveyance in wireless sensor network. In any case, information accumulation exactness was not at the necessary level.

E. EADSLPBNCDA

During ceaseless data aggregation from sensor nodes the node energy level gets diminished. This decreases the system lifetime in wireless sensor network. So the accuracy of the data aggregation was not expanded and energy utilization during information accumulation was not decreased. In light of this inspiration, the efficient energy data aggregation is introduced for prolonging the lifetime of the network system by executing node arrangement as higher energy nodes and lower energy nodes in this procedure. The lower energy sensor nodes send the information to the higher energy sensor nodes (37). By along these lines, data agglomeration is done by above model.

To perform the node categorization this technique used two concepts one is decision stump is a feeble categorizer which is categorize the higher energy node and lower energy node separately by the help of fixed value and it is feeble categorizer and another one is linear programming boosting method which joints the feeble categorizer results and calculates the error value. Later on, depending on the error value mass is renewed. That the boosting classification technique provides robust classification results with minimal error. To increase WSN's network lifetime, lower energy sensor nodes send data packets to neighbouring higher energy sensor nodes. Manhattan distance used to find out the distance between the two sensor nodes. At last, the sink node gathers information from all higher energy sensor nodes. This improves information collection execution with negligible delay and this sort of conventions limit the excess information transmission. The performance of categories the nodes discussed in the next section.

III. SYSTEM MODEL

The below cases has been showed system model of each technique.

A. Tree-based data aggregation approach in wireless sensor network using fitting functions

In their simulations, the authors this method used true values are noted from 54 sensor nodes used in the Intel Berkeley Research Lab. Sensors are gathering temperature, light, voltage, and humidity values per 31 sec. Every sensor senses an average of 90000 values / day.

In experiment 1, every recorded value is taken from two parameters such as temperature and humidity. In experiment 2, every recorded value is noted from three parameters such as temperature, humidity and voltage. Bayesian Belief network "BBN" a supervised learning algorithm used for further steps. Classified Skin Segmentation Data Set used in this step, because the data they were taken from Intel Berkeley Research Lab is uncategorized. The noted data size is 150,000 records; in that skin sample are 50859 and non-skin sample are 99141. Every record has three parameters: red, green, and blue. Classification values of 1 for skin and 2 for non-skin. Recognizing skin or non-skin samples will allow identifying easily by the image processing. Using local aggregation technique in first experiment the data size becomes 1799 record out of 85829. Moreover, the size of the remaining data is reduced to 923 using prefix filtering, with threshold t = 0.7 and link function = 1. Here the experiment is done with two parameters: temperature and humidity.

In second experiment 2, three parameters are used such as temperature, humidity and voltage with the fitting function Poly2d. X-axis of the fitting surface is temperature, the y-axis for humidity and the z-axis for voltage. The below diagram showed the fitting phase of three-axis. The performance results are shown in the next section. Later this experiment tested, the number of records is 55512, and after prefix filtering the rest of the data are 27355 records, so this method saving 81.76% of the original data. This method selects Poly2d function for that this method used OriginPro software and used fitting surface simulation.

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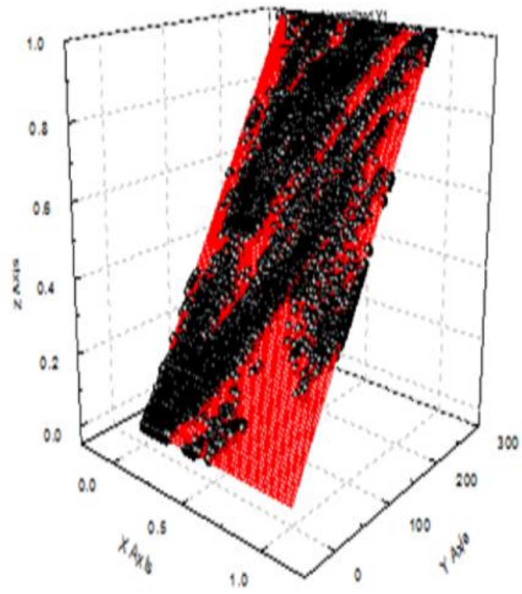

Fig.10. Fitting surface for new data

B. TTDFP

In this method, member nodes transmitted data to their cluster head indirectly using single-hop method. So cluster head assemble those data, aggregate that data, and send it to the base station by using a multi-hop routing method. The utilized model of this method is shown in fig.11. In the figure, the sink is represented with black colour, which domiciled in the working area, cluster head are shown in red, member nodes are in blue colour, and competing rays of final cluster heads are shown as dotted circles. Black Lines represent direct communication channel, whereas green colour lines represent the multi-hop communication channel.

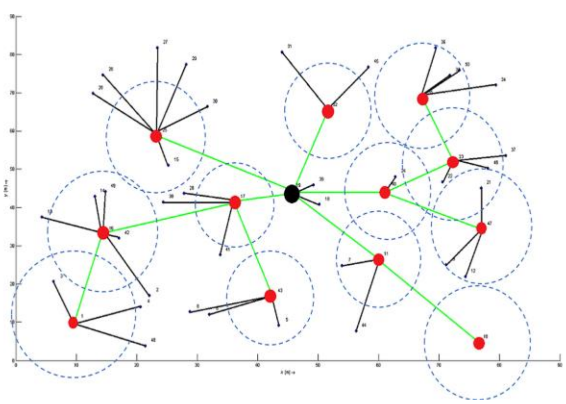

Fig.11. Utilized Model

This method has two tiers. In tier 1, fuzzy clustering algorithm choose bunch of cluster head to increase efficient energy in the network. Owing to this method is designed by three elements and three parameters. 1. Efficient energy, 2.Scalability and 3.Run-time configuration. And the three parameters are 1.Node energy, 2.Node communication and 3.Distance to sink with the objective of determining the competitive radius value for temporal cluster head.

In tier 2, the best routing path from cluster head to the base station is found out by the fuzzy routing protocol. ALRE and RD are used as two fuzzy input parameters to prolong the defined multi-hop routing method.

$$RD_r = \frac{\text{Distance}}{\max\ (\text{Distance})}$$

$$ALRE_r = \frac{\sum_{i=1}^{m} RE_i}{\max\ (\text{Distance})}$$

In this experiment, to evaluate efficient energy in represented protocol, First node dies (FND), Half node dies (HND), and total remaining energy (TRE) are chosen. These two-tiers are unified to give an efficient data aggregation. The performance results are shown in the next section.

C. Multi-mobile agent itinerary planning-based energy and fault aware data aggregation

This method has three phases: (1) Cluster Head selection and formation (2) Cluster Head based routing plan, (3) MA migration and data aggregation.

(1) Cluster Head selection and formation

This method constructed some algorithms to achieve their goals. Algorithm 1 is to choose the cluster head and add all SNs to the cluster in its sector, and the source nodes added in one cluster are not take part in any other clusters. Second, it can create a second cluster by selecting a second Cluster Head with elevated SNs. Finally, repeat that process as long as there is no sensor node outside a cluster. Algorithm 2 used to generate the route. Routes for mobile agents can be set up amid of the cluster head by using the minimum spanning tree (MSD).

(2) Cluster Head-based routing plan

From selective Cluster Head are susceptible Sensor Nodes to failure, the fault tolerance elements is essential in wireless sensor network in belligerent and severe environments. To avoid node failures that already present in wireless sensor network, a re-clustering technique is used. To attain fault tolerance by re-clustering, another Cluster Head and set the route using MST was selected. Through this, alternatives to MAs are planned if the first ones fail.

(3) MA migration and Data Collection

Algorithm 3, forward an MA to every of the route in MCH for data collection, after setting routes within the last phases. Algorithm 4, selects routes with the minimum weight to organize routes on those CHs using MST, after choosing secondary cluster heads.

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This model evaluated by four metrics

- Total energy consumption is the energy taken by every sensor node and mobile agent implementation.
- Execution time is the needed time for mobile agent to invoke whole cluster head and revert to the base station.
- Total travelled distance by whole mobile agents.
- Transmitted MAs is the number of sending mobile agents to collect data from cluster head.

This approach performed clusters based on SN density by using choose the node with the higher energy as cluster head, then design the route amidst cluster head using a minimum spanning tree. But in the case of failure cluster head, the mobile agents cannot migration.

Hence, a fault tolerance based on another route model is used due to failure the sending mobile agents due to nodes failure shown in fig 12. This model addressed, due to partial failure occur, that is node can possible to communicate, but it not able to sense or collect any data. The performance results of this method are showed in the next section.

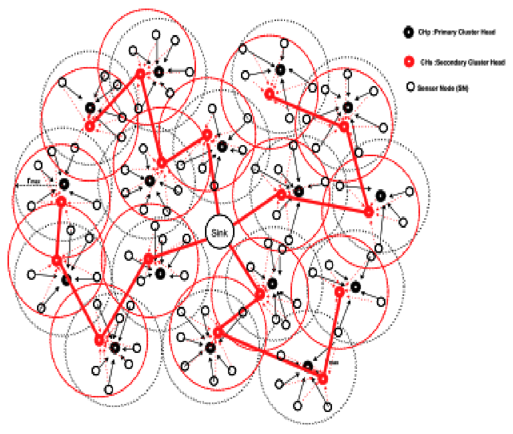

Fig.12. Fault tolerance based on alternative itinerary planning

D. E- ZEAL

This method intended to improve the performance of data delivery and consumption of energy in existing ZEAL method. This method changes some calculation and incorporates new methods in the setup phase; to enhance the preferment of sub-sink nodes directs to improve in data delivery. And also, this method used the K-means clustering algorithm within the pre-processing phase to seek out the simplest route for the mobile sink to cut back energy consumption. For test cases, the network area is set to 400 m, 200 m, 120 nodes are used arbitrarily. Tests are conducted again and again with various indiscriminately seeds for validation.

To given the optimal value of k as input to the K-means clustering algorithm, Silhouette method is used in the pre-processing phase. The member and sub-sink nodes are categorized into clusters. Set the centroid of each cluster and joining the centroids of every cluster via fixed route. In contrast, the mobile-sink moves back and forth on a horizontal line by fixed a direct path at the base of the network area in ZEAL method. Hence, EZEAL carry out a downsizing in the distance and the hops (Nhops) between member and sub-sink nodes. To show the downsizing, an experimental setup is conducted to determine the hops (Nhops) and therefore maximum distance within the entire network for whole member and sub-sink nodes. E-ZEAL brings off 50% in downsizing in Nhops and distance. The method increased the performance of data delivery and energy consumption over ZEAL. A test is conducted to estimate the average residual energy in the data delivery and network energy.

The performance of data delivery in ZEAL and E-ZEAL path are shown in fig.13. It is noted that E-ZEAL did data delivery by 240 data packets in two data collection cycles for 120 nodes. E-ZEAL preserves energy for member nodes for two data-collection cycles. It has time saving energy consumption aims to prolong the lifetime of member nodes. 23 cycles later, the residual energy of ZEAL and E-ZEAL is 261 and 845 J respectively, depicting 8% and 28%. Middle path, diagonal-path, letter-V, and zigzag-path are used to estimate the route in E-ZEAL. Flow monitor modules are used in ns-3 simulator to increase the nodes lifetime in the network by 30% than ZEAL and reduce the end-to-end delay time by 30% and 20% throughput is increased in all over the network densities. The throughput is evaluated by the amount of the sending data per second [bps]. The performance results are shown in the next section.

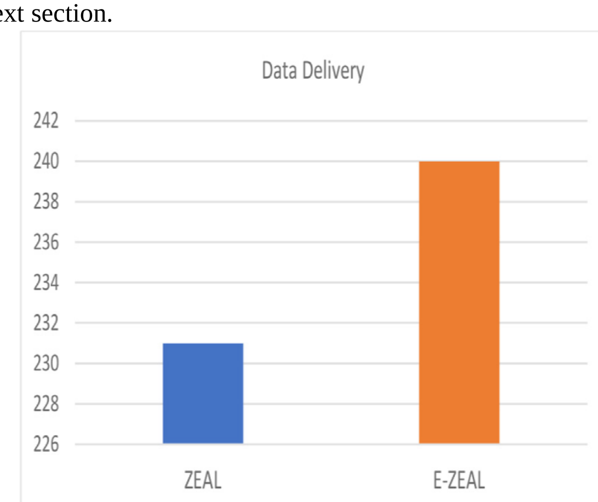

Fig.13. Data Delivery Performance

E. An Energy-Aware Decision Stump Linear Programming Boosting Node Classification based Data Aggregation (EADSLPBNC-DA):

This model is developed to increase the performance of data collection by node classification in wireless sensor networks with minimal time. Here, decision stump is a decision Tree that works only a one remaining energy for classification of node. This decision stump is known as a one-level decision tree. This decision stump always gives a lower classification performance.

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Therefore, Linear Programming Boosting is used. By incorporating decision stump and linear programming boosting techniques this method achieves better performance of node classification and thereby reached reliable data collection in wireless sensor networks. This Method used machine learning program to converts the feeble decision stump classification results into robust. The block diagram of EADSLPBNC-DA Method is shown in Fig. 14.

The overall process of the given architecture is, WSN contains n number sensor nodes next this model calculate the residual energy for each sensor node. This method used linear programming boosting classification to convert feeble decision stump into a robust and increase the node classification accuracy by adding 'n' number of feeble decision stump results to reduce the node classification error rate.

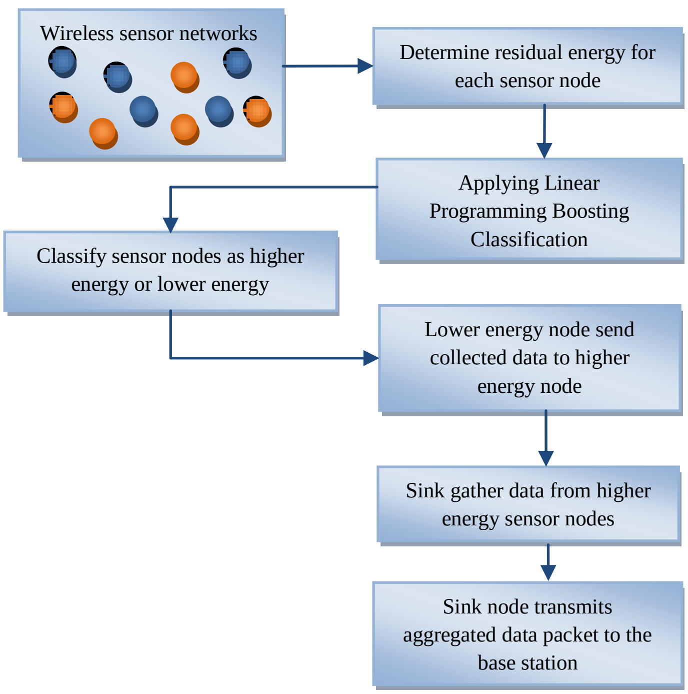

Fig.14. Architecture of EADSLPBC-DA

According to threshold value, Decision stump categories the sensor node like higher energy node or lower energy node. If the remaining energy level of the node '$RASi$' is greater than the threshold value 'δ', then the sensor node 'Si' is categories higher energy node. Otherwise, it is categories lower energy node. After this sorting process, lower energy node sends the aggregated data to the higher energy node. At last, the sink node gather the data from that the higher energy sensor node and transmitted the aggregated data to the sink. To estimate the performance of this method, NS2.34 network simulator used by taking the area of 1200 square m. The performance of this method is defined in terms of consumption of energy, data aggregation accuracy, lifetime of the network, delay and data aggregation time by the total number of sensor nodes and the total number of data packets that discussed in the next section.

IV. PERFORMANCE EVOLUTION

A. Categorization of Data Aggregation:

- **The Expression of energy consumption:**

  Energy consumption evaluates the amount of energy consumed by sensor nodes to collect data packets. The expression for energy consumption is,

$$EC = N \text{ x } (Si) \quad (10)$$

From the above equation,

N - Total number of sensor nodes

Si - Energy occupied by each node to collect data.

- **The Expression for network lifetime:**

  Network lifetime is defined as the ratio of the number of high energy sensor nodes is chosen to enable the energy efficient data aggregation with the total number of sensor nodes. The expression for network lifetime is,

$$NL = \frac{N_{HENS}}{N} \text{ X } 100$$

- **Performance measure of data aggregation accuracy**

  Data aggregation accuracy 'DAA' is defined as the ratio of the total number of data packets correctly collected by the sink node to the total number of data packets sent. The expression for data aggregation accuracy is,

$$DAA = (NDCC/ndp) \text{ x } 100$$

From the above mathematical equation,

$NDCC$ – the total number of data packets correctly collected.

ndp **-** the total number of data packets sent.

- **Performance measure of data aggregation time**

  Data Aggregation Time calculates the time it takes for the sink node to collect data packets from high power sensor nodes. The data aggregation time is expressed as,

$$DAT = M \text{ x } t$$

From the above equation,

M - Total number of data packets

t - Time utilized to gather the data packets.

- **Performance measure of delay**

  Delay is defined as the difference between time taken for data aggregation of actual time and expected time. Then the expression for delay is,

$$Delay = Actual\ time - Expected\ time$$

B. Performance measure of following techniques

1. Tree based method

In this method a "Bayesian Naive Classifier" machine learning method is used and half of the percentage of data used for learning and half of the percentage used for testing. The performance results are shown below.

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The accuracy of this method attained 91 %. Without aggregated, the accuracy attains 93.8%, which is nearest to the earliest. This method was therefore reduced to no significant impact on the accuracy of the transmitted data.

	Aggregated data	All data
Accuracy	91%	93.8%

2. Two Tier Distributed fuzzy logic

This model aims to prolong multi-hop's lifetime. To determine the performance of TTDFP, it compared with the earlier protocols that already existing in literature survey, such as LEACH, CHEF, EEUC, MOFCA etc. In this experiment, three metrics for calculating efficiency of energy of the protocols conducted. Those metrics are First node dies (FND), Half node dies (HND), and total remaining energy (TRE). OMNET++ with Castalia platforms used for the simulation. Wireless sensor nodes are indiscriminately used in1000 square meter area and the energy of each node is 1J.

(a) Energy consumption in TTDFP :
Total Sensor nodes = 50
Energy used/sensor = 1J

Then the energy consumption is

$$EC = 50 * 1 \text{ J} = 50 \text{ J}$$

(b) Network Lifetime in TTDFP is 90% of sensor nodes are active high. So,

$$Network\ lifetime = (45/50) \times 100 = 90\%$$

(c) The Aggregation ratio of Two-Tier Distributed Fuzzy Logic Based Protocol is 10%.

3. MAEF

(a) Calculation for Energy Consumption:

Total Sensor nodes = 50
Energy used/sensor = 0.62J

Then the energy consumption is

$$EC = 50 \times 0.62 \text{ J} = 31 \text{ J}$$

(b) Calculation for Network Lifetime:

Total Sensor nodes = 50
Higher energy sensor nodes = 41.

Then the network lifetime is

$$Network\ lif\ etime = (41/50) \times 100 = 82\%$$

(c) Calculation for data aggregation accuracy:

Total data packets collected = 21
The actual data packets sent = 25

Then the data aggregation accuracy is,

$$DAA = (21/25) \times 100 = 84\%$$

(d) Calculation for data aggregation time:

Total data packets = 25
Time taken for each data packet = 0.8ms.

Then the data aggregation time is,

$$DAT = (25 * 0.8 \text{ ms}) = 20 \text{ ms}$$

(e) Calculation for the delay:

Total data packets = 25
Expected data aggregation time = 15ms.
The actual data aggregation time =20ms.
Then the delay time is,

$$Delay = (20 \text{ ms} - 15 \text{ ms}) = 5 \text{ ms}$$

4. E-ZEAL

(a) Calculation for Energy Consumption:

Total Sensor nodes = 50
Energy used/sensor = 0.59J

Then the energy consumption is

$$EC = 50 \times 0.59 \text{ J} = 29 \text{ J}$$

(b) Calculation for Network Lifetime:

Total Sensor nodes = 50
Higher energy sensor nodes = 43.

Then the network lifetime is

Network Lifetime = (43/50) x 100 = 86%

(c) Calculation for data aggregation accuracy:

Total data packets collected = 19
The actual data packets sent = 25
Then the data aggregation accuracy is,

$$DAA = (19/25) \times 100 = 76\%$$

(d) Calculation for data aggregation time:

Total data packets = 25
Time taken for each data packet = 0.7ms.

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Then the data aggregation time is,

$$DAT = (25 \text{ x } 0.7 \text{ ms}) = 18 \text{ ms}$$

(e) Calculation of delay:

Total data packets = 25
Expected data aggregation time = 14ms.
The actual data aggregation time =18ms.

Then the delay time is,

$$Delay = (18 \text{ ms} - 14 \text{ ms}) = 4 \text{ ms}$$

5. EADSLPBNC-DA

(a) The calculation for Energy Consumption:

Total Sensor nodes = 50
Energy used/sensor = 0.45J

Then the energy consumption is

$$EC = 50 * 0.45 \text{ J} = 23 \text{ J}$$

(b) The calculation for Network Lifetime:

Total Sensor nodes = 50
Higher energy sensor nodes = 48.

Then the network lifetime is

Network Lifetime = (48/50) x100 = 96%

(c) The calculation for data aggregation accuracy:

Total data packets collected = 24
The actual data packets sent = 25

Then the data aggregation accuracy is,

$$DAA = (24/25) \text{ x } 100 = 96\%$$

(d) The calculation for the data aggregation time:

Total data packets = 25
Time taken for each data packet = 0.45ms.
Then the data aggregation time is,

$$DAT = (25 \text{ x } 0.45 \text{ ms}) = 11 \text{ ms}$$

(e) The calculation of delay in mathematically:

Total data packets = 25
Expected data aggregation time = 9ms.
The actual data aggregation time =11ms.

Then the delay time is,

$$Delay = (11 \text{ ms} - 9 \text{ ms}) = 2 \text{ ms}$$

The above calculation is given below in tabular column for comparison of current techniques of data aggregation used in wireless sensor networks.

C. Performance table of various data aggregation techniques

Techniques	Energy Consmption (J)	Network Lifetime	Accuracy	Data Aggregation Time (ms)	Time delay (ms)
Tree Based fitting	-	-	91%	-	-
TTDFP	50J	90%	Ratio 10%	more	more
MAEF	31J	82%	84%	20	5
E-ZEAL	29J	86%	76%	18	4
EADSLPBNC-DA	23J	96%	96%	11	2

D. Techniques and their disadvantages

Techniques	Disadvantages
Tree Based fitting	Less transmission of data, concentrated on Data Accuracy
TTDFP	More Time taken for collecting data
MAEF	Network Lifetime and accuracy is reduced
E-ZEAL	Accuracy is reduced
EADSLPBNC-DA	Data traffic Congestion and Redundancy during data aggregation process

V. CONCLUSTION

One of the technique handling by Wireless Sensor Network for better performance is the data aggregation. For that, wireless sensor networks require inventive solutions to overcome the issues and barriers confront by the network. So the focus is on improving data collection techniques and discerning data aggregation as the major issues shown and efforts have been made to gather a more holistic view of existing data aggregation methods. By analyzing various data aggregation approaches and presenting their pros and cons, it helps the reader to have a clear view of the various issues in the wireless sensor network. By studying this paper, it is clear that a comprehensive and coherent approach to the level of debate and data collection is being undertaken. Yet a more detailed and observable approach is needed, which is ability of incorporating energy consumption, data accuracy, aggregation time, security, overhead in the communication and compression of data rate.

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REFERENCES

1. Wireless Sensor Networks: Issues & Challenges Indu et al, International Journal of Computer Science and Mobile Computing, Vol.3 Issue.6, June-2014, pg. 681-685
2. I.F. Akyildiz, W.Y. Sankarasubramaniam, A survey on sensor networks, IEEE Communications Magazine (2002) pp. 103–112.
3. Nikolaos A. Pantazis, Stefanos A. Nikolidakis and Dimitrios "Energy-Efficient Routing Protocols in WSN: A Survey," IEEE Communications Surveys & Tutorial, vol 3, pp. 1-41, 2012.
4. Nikolaos A. Pantazis, Dimitrios, "A survey on power control issues in wireless sensor networks," IEEE Communications Surveys and Tutorials: 86-107 (2007).
5. Ridha Souaand Pascale Minet, "A Survey on Energy Efficient Techniques in Wireless Sensor Networks,"IEEE Technical Program at IFIP WMNC' 2011.
6. T. N.Qureshi, T. Shah and N. Javaid. EESAA: Energy Efficient Sleep Awake Aware Intelligent Sensor Network Routing Protocol. Islamabad, PK on December 2012.
7. G. Anastasi, M. Conti, M. Francesco, A. Passarella, "Energy Conservation in Wireless Sensor Networks: A Survey," Ad Hoc Networks, 2009, Vol. 7, Issue 3, pp.537-568.
8. Srisooksai, T., Practical data compression in wireless sensor networks: A survey. Journal of Network and Computer Applications, 35(1), 37–59. 2012.
9. Rezazadeh, J., Subramanian, R., Sandrasegaran, K., Kong, X., Moradi, M., & Khodamoradi, F. (2018). Novel iBeacon placement for indoor positioning in IoT. IEEE Sensors Journal, 18(24), 10240–10247.
10. Soroush Abbasian Dehkordi and Kamran Farajzadeh data aggregation techniques in IoT sensor networks Published online: 25 September 2019 at Springer Science+Business Media, LLC, part of Springer Nature 2019
11. Rezazadeh, J., Sandrasegaran, K., & Kong, X. A location- based smart shopping system with IoT technology. In IEEE 4th World Forum on Internet of Things (WF-IoT) (pp. 748–753).Singapore.2018
12. Ms. S.Sahana and Dr. R.Amutha Data Aggregation in Wireless Sensor Networks ISBN No.978-1-4799-3834-6/14/$31.00©2014 IEEE.
13. Mrs. P.Padmaja, Dr.G.V.Marutheswar ENERGY EFFICIENT DATA AGGREGATION IN WIRELESS SENSOR NETWORKS © 2017 Elsevier Ltd. All rights reserved. 2016, Ongole, Andhra Pradesh, India
14. Mousam Dagar and Shilpa Mahajan Data Aggregation in Wireless Sensor Network: A Survey International Journal of Information and Computation Technology. ISSN 0974-2239 Volume 3, Number 3 (2013), pp. 167-174
15. Sukhchandan Randhawa and Sushma Jain Data Aggregation in Wireless Sensor Networks: Previous Research, Current Status and Future Directions Published online: 28 July 2017_ Springer Science+Business Media, LLC 2017
16. Sirsikar and Anavatti issues of data aggregation techniques in WSN: A survey. © 2015 The Authors. Published by Elsevier B.V. (http://creativecommons.org/licenses/by-nc-nd/4.0/).
17. Parmar and Jinwala Concealed data aggregation in wireless sensor networks: A comprehensive survey comnet.2016.04.013 1389-1286/© 2016 Elsevier B.V. All rights reserved.
18. E. Fasolo, M. Rossi, J. Widmer, M. Zorzi, In-network aggregation techniques for wireless sensor networks: A survey, pp. 70–87, 2007.
19. Nandhini and Prof. Patil, "Data Aggregation in WSN, IEEE international conference on computational intelligence and computing research, ISBN: 97881 8371 3627.
20. Sandeep Kaur and R.C. Gangwar A Study of Tree Based Data Aggregation Techniques for WSNs ISSN: 2005-4270 IJDTA Copyright ⓒ 2016 SERSC .International Journal of Database Theory and Application Vol.9, No.1 (2016), pp.109-118
21. Zaib Ullah A Survey on Hybrid, Energy Efficient and Distributed (HEED) Based Energy Efficient Clustering Protocols for Wireless Sensor Networks © Springer Science+Business Media, LLC, part of Springer Nature 2020
22. Ali Shokouhi Rostami and Marzieh Badkoobe Survey on clustering in heterogeneous and homogeneous wireless sensor networks Published online: 21 September 2017 © Springer Science+Business Media, LLC 2017
23. Chen, H., Mineno, H., & Mizuno, T. (2008). Adaptive data aggregation scheme in clustered wireless sensor networks. Computer Communications, 31(15), 3579–3585.
24. Ibrahim Atoui and Ali Ahmadt Tree-based data aggregation approach in wireless sensor network using fitting functions, ISBN: 978-1-4673-7504-7 ©2016 IEEE
25. J.-R. Jiang, C.-M. Lin, F-y' Lin, and S.-T. Huang, "Alrd: Aoa localization with rssi differences of directional antennas for wireless sensor networks," Information Society (i-Society), 2012 International Coriference on, pp. 304-309, 2012.
26. Seyyit Alper Sert, Abdullah Alchihabi , , Member, IEEE and Student Member, IEEE, A Two-Tier Distributed Fuzzy Logic Based Protocol for Efficient Data Aggregation in Multihop Wireless Sensor Networks 1063-6706 © 2018 IEEE.
27. A. Alchihabi, A. Dervis, E. Ever, and F. Al-Turjman, "A Generic framework for optimizing performance metrics by tuning parameters of clustering protocols in WSNs," pp. 1–15, 2018.
28. Mohamed El Fissaoui, Abderrahim Beni-hssane, Mostafa Saadi, Multi-mobile agent itinerary planning-based energy and fault aware data aggregation in wireless sensor networks, EURASIP J. Wireless Commun. Networking 2018 (92) (2018) 1–11, Springer.
29. S Rani, SH Ahmed, Multi-hop Routing inWireless Sensor Networks–An Overview Taxonomy and Research Challenges. (Springer, Singapore, 2016).
30. K Moizumi, G Cybenko, The traveling agent problem. Math. Control Signals Syst. 14(3), 213–32 (2001).
31. A Beni Hssane, ML Hasnaoui, M Saadi, S Benkirane, M Laghdir, Equitable leach-e protocol for heterogeneous wireless sensor networks. Stud. Comput. Intell. 315, 171–6 (2010). https://doi.org/10.1007/978-3-642- 15211-518. cited By 3
32. S Chouikhi, IE Korbi, Y Ghamri-Doudane, LA Saidane, A survey on fault tolerance in small and large scale wireless sensor networks. Comput. Commun.69,22–37 (2015). https://doi.org/10.1016/j.comcom.2015.05.007
33. Olariu, S., Stojmenovic, I., "Design guidelines for maximizing lifetime and avoiding energy holes in sensor networks with uniform distribution and uniform reporting". 25TH IEEE International Conference on Computer Communications. IEEE, pp. 1–11 .doi: 10.1109/INFOCOM.2006.296.
34. Aya H. Allam, Mohamed Taha, Hala H. Zayed, Enhanced zone -based energy aware data collection protocol for wsns (E-ZEAL), J. King Saud Univ. - Comput. Inf. Sci. (2019) 1–22, Elsevier.
35. Xing, G., Wang, T., "Rendezvous design algorithms for wireless sensor networks with a mobile base station. 9th ACM International Symposium on Mobile Ad Hoc Networking and Computing – MobiHoc '08. ACM Press, New York, USA, p. 230,231, 2008.
36. Al-Shalabi, M., Anbar, M., Wan, "Variants of the low energy adaptive clustering hierarchy protocol: survey, issues and challenges". Electronics 7, 136. 2018.
37. S. Sankaralingam and N. Sathishkumar Nagarajan, Energy aware decision stump linear programming boosting node classification based data aggregation in WSN, 0140-3664/© 2020 Elsevier B.V. All rights reserved.
38. Chao Sha, Jian-mei Qiu, Shu-yan Li, Meng-ye Qiang, Ru-chuan Wang, A type of energy-efficient data gathering method based on single sinks moving along fixed points, Peer-to-Peer Netw. Appl. 11 (3) (2018) 361–379, Springer.
39. J. Kulshrestha, M.K. Mishra, "An adaptive energy balanced and energy efficient approach for data gathering in wireless sensor networks, Ad- Hoc Network. 130–146, 2017. Elsevier.
40. Sukhchandan Randhawa, Sushma Jain, Data aggregation in wireless sensor networks: Previous research, current status and future directions, Int. J. Wirel. Pers. Commun. 97 (3) (2017) 3355–3425, Springer.
41. V. Saranya, S. Shankar, G.R. Kanagachidambaresan, Energy efficient data collection algorithm for mobile wireless sensor network, Wirel. Pers. Commun. 105 (1) (2019) 219–232, Springer.
42. Duc Tai Le, Taewoo Lee, Hyunseung Choo, Delay-aware tree construction and scheduling for data aggregation in duty-cycled wireless sensor networks, EURASIP J. Wirel. Commun. Netw. 2018 (95) (2018) 1–15, Springer.
43. Yong Lu, Na Sun, A resilient data aggregation method based on spatiotemporal correlation for wireless sensor networks, EURASIP J. Wireless Commun.Networking 2018 (157) (2018) 1–9, Springer.
44. Cuicui Lv, Qiang Wang, Wenjie Yan, Jia Li, A sparsity feedback-based data gathering algorithm for wireless sensor networks, Comput. Netw. 141 (2018) 145–156, Elsevier.

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45. Mohamed El Fissaoui, Abderrahim Beni-Hssane, Mobile agent protocol based energy-aware data aggregation for wireless sensor networks, Procedia Comput. Sci. 113 (2017) 25–32, Elsevier.
46. R. Vijayashree, C. Suresh Das, "Energy efficient data collection with multiple mobile sink using artificial bee colony algorithm in large-scale WSN,. 60 (5) (2019) 555–563, Taylors and Francis.
47. Ying Zhou, Lihua Yang, Longxiang Yang, Meng Ni, Novel energy-efficient data gathering scheme exploiting spatial-temporal correlation for wireless sensor networks, Wirel. Commun. Mob. Comput. 2019 (2019) 1–10, Hindawi Publishing Coorporation.
48. Masanari Iwata, Suhu Tang, Sadao Obana, Energy-efficient data collection method for sensor networks by integrating asymmetric communication and wake-up radio, Sensors 18 (4) (2018) 1–17.
49. S. Balakrishnan, J.P. Ananth, L. Ramanathan, S.P. Premnath, An adaptive energy efficient data gathering in wireless sensor networks, Int. J. Pure Appl. Math. 118 (20) (2018) 2501–2510.
50. J. Srimathi, V. Valli Mayil, Fuzzy gene optimized reweight boosting classification for energy efficient data gathering in WSN, Int. J. Comput. Netw. Commun. (IJCNC) 11 (2) (2019) 95–112.

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