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Hybridization of Energy Efficient Clustering and Multi-Heuristic Strategies to Increase Lifetime of Network

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Abstract—Conserving energy so that data collection can be prolonged is discussed through this paper. Lack of time and hectic life causes disease to spread at wild rates. To this end, technology plays critical role in the detection and prevention of diseases. IoT(internet of things) is an emerging field that operates on real time datasets to detect any abnormality through classification modeling. Sensor is an integrated component of IoT that is used to collect data and then store within data store. Sensors have limited energy associated with them. There are number of mechanisms including LEACH, DEEC, MDEEC, EDEEC etc. all these mechanisms conserve energy but optimization in each protocol is missing. Problems associated with listed protocols are discussed and mechanisms used to overcome the problems are also briefed. Comparative analysis suggests DEEC protocol is best among all and can be used for optimization purpose. Health predictions will be better in case sensors are in good health.

Parameters: Residual Energy, Lifetime, Packets sent to base station, packet sent to controller
Achievement: The health of sensors and lifetime of network is increased through optimization mechanisms- GA, PSO, ACO
Keywords- Optimization Algorithms, Sensors, Health Monitoring, Packets to controller, Packets to base station, Energy Efficiency

I. INTRODUCTION

Intelligence along with technology combined together to achieve the objective of health prediction using applications of IoT. IoT involve sensors, service provider , cloud etc. [1]Combining multiple techniques gives rise to fog computing. In today's world, doctor uses cloud services to store data of patient and assign them with unique ids. This means data of patient can be accessed anytime anywhere. As more and more data collected together to form large dataset, certain filtering mechanisms are required in order to fetch data in correct way. Data mining thus comes into frame and forms integral part of data fetching mechanism. In order to access health based services from IoT user must have account with cloud service provider and user requires to pay according to services they access. Basic components and structure of IoT driven health monitoring system is given in figure 1 [2]Building block of this structure is sensors. Sensors used to sense abnormal data from client. These sensors can be attached to human body through electronic equipments like smart bands, watches, phones etc. sensors consume energy as data is transmitted from source station towards destination station.

[3]Energy conservation is critical as loss of energy causes loss of data packets. In addition lifetime of network decreases considerably due to energy loss. In internet of things, throughput is the main parameter that is to be enhanced using LEACH, DEEC, EDEEC etc mechanism. In addition to these mechanisms there is also a sleep and wake protocol that causes sensors to shut off if it is not used for long period of time. As soon as sensor services are required, wake up mechanism put the sensor to work leading to conservation of energy. All of these mechanisms are discussed in section 2.

Another critical component is cloud in which data storage is performed. Information about health corresponding to patient is stored at centralized location within cloud. To access cloud services, client must have direct access to resources. To this end cloud service subscription is required. Once subscription is performed, SLA is established. Service level agreement cannot be violated by client and service provider.

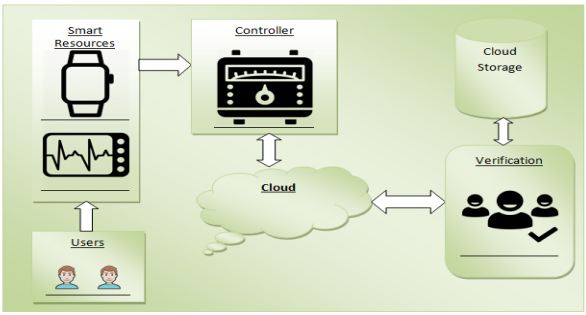

Figure 1: General Structure of IoT based health monitoring

User smart devices send the data towards controller and controller have access to cloud. To transfer and receive data from cloud, client account with the service provider is

verified. Once verification succeeds then information access is granted to controller. In this case local devices are nodes and controller act as cluster head and cloud storage section along with information retrieval point at health center act as base station.

Rest of the paper is described as under: section 2 provide in depth into different mechanisms that can be used to conserve energy of sensors, section 3 gives comparative study of techniques, section 4 gives conclusion and future scope and last section gives references.

II. SENSOR ENERGY CONSERVATION MECHANISMS

Considering energy efficiency during data transmission from patient side to base station(doctor's end) is state of the art problem. Leading technologies both in terms of hardware and software are considered to maximize the lifetime of network. This section briefly describes the mechanism used to provide energy efficiency during data transmission.

A. LEACH

[5], [6]LEACH is a low energy adaptive clustering protocol. This is a hierarchical protocol that is used to conserve energy during data transmission. Nodes (clients) transfer data to cluster head(controller) and aggregated packets at base stations are compressed and transmitted towards base station. Stochastic algorithm is followed by nodes to determine whether it becomes a cluster head or not. Nodes that have become cluster head cannot become cluster head again for P rounds and each node has 1/P probability of becoming cluster head. TDMA approach is used by nodes to communicate with each cluster head. There are different approaches followed by researchers to enhance LEACH protocols that are given by table 1

Table 1: LEACH Protocol enhancement mechanism comparison

References	Technique	Advantage	Disadvantage
[7]	LEACH	Energy efficient and secure mechanism since cluster head selection not only consider energy efficiency but also CH vicinity with symmetric key integration	Distance between cluster head is not considered causing early decay of network.
[8]	Cluster Chain Weight Metrics approach	It reduces the overhead of the net- work but also reduces the communication cost.	Load distribution is high
[9]	ERA	It saves energy as each node decides itself to join a CH by considering both the residual energy of the CHs and the distance.	
[5]	P-LEACH	Node that has maximum energy is selected as cluster head so it is energy efficient	Communication overhead does not handled efficiently

a. DEEC

Distributed energy efficient clustering protocol is used to enhance energy efficiency that is not possible through LEACH protocol. The DEEC protocol is based on selecting multiple cluster head in one round rather than single cluster head per round thereby increasing rate at which packets are transferred towards destination. DEEC protocol is worked upon by researchers as described by table 2.

Table 2: Comparison of DEEC enhanced approaches

References	Technique	Advantage	Disadvantage
[2]	Varying power based clustering algorithm	Clustering algorithm employed saves energy and packet drop ratio is considerably reduced	Packet drop ratio can be further reduced by employing additional memory with sensors
[1]	Performance evaluation of DEEC	Performance of DEEC, EDEEC, TDEEC and other clustering protocols are analyzed. This approach identify best possible approach of clustering as TDEEC	Memory based clustering approach is not suggested
[10]	EDEEC	Enhanced DEEC consider and energy to declare node as cluster head. Higher degree of packets able to reach destination using this approach	Memory based clustering approach is missing causing degradation of lifetime of network

B. MDEEC

Modified DEEC approach using power based and distance based approach for forming clusters. Data will be transmitted from multiple cluster heads to base station and hence rate at which data is transmitted enhanced greatly. Cluster head once selected is neglected from cluster head list. Every node present within cluster can be selected with 1/p probability. Table 3 described MDEEC protocol enhancement mechanisms

Table 3: MDEEC enhancements and future enhancements

References	Technique	Advantage	Disadvantage
[11]	MDEEC	It is modified distributed clustering protocol in which energy efficiency is achieved	MDEEC without memory efficiency causes lifetime degradation
[12]	Heterogeneous DEEC	Nodes with different configuration can be selected as cluster head	Priority queue can be established in future to decrease packet drop ratio

III. OPTIMIZATION MECHANISMS FOR SELECTING OPTIMIZED SENSORS FOR DATA TRANSMISSION

Optimization mechanism ensures selection of nodes(sensors) that could improve performance in terms of rate at which data is transmitted and received. This communication mechanism ensures transfer of information to desired health center and then information from health center to client side. This section describes optimization mechanisms as under

A. Genetic Algorithm

[13]This is one of the oldest and best approaches for achieving best in class objective based result. This process uses modular approach that reduces complexity in achieving desired objective function. This is iterative approach and increase execution time in achieving desired result. Different phases associated with GA are discussed as under

1) Initialization

This phase is a first phase and perhaps the most important one since it is used to initialize the population from which data for operation is selected. This process is also known as population selection mechanism. inIoT based health prediction, population can be collection of sensors with varying distance{x1,x2,x3,--------,xn}. Random selection process can be used for the selection of sensors. Next phase evaluate fitness function and checks optimized value obtained after evaluation.

2) Fitness function evaluation

It assign fitness value to each individual node. The probability that individual is going to be selected depend upon fitness score.

3) Selection

This phase select individual having highest fitness score and let them pass to next phase or generation for evaluation.

Two pair of individuals(Parent) are selected based on fitness score. Individual having highest fitness score is likely to be selected for reproduction.

4) Crossover

This is most significant phase that is used to decide crossover point at random from within chromosomes. Offspring are generated by combining genes up-to crossover point and new population is generated for evaluation.

5) Mutation

This phase is critical is used in order to maintain diversity within population so that convergence can be achieved within fixed interval of time. Mutation is required of offspring having low random probability. Gene mutation allow optimized result in terms of objective function.

Problem with genetic approach is convergence rate. Poor convergence, in case of inaccurate initial approximation causes high execution time for genetic based approach. To overcome the problem other multi heuristic approach like ACO is used.

B. ACO

Ant colony optimization is another multi heuristic approach hat is used to achieve better result in terms of optimization function. It is commonly used to solve computational problems. ACO is based upon the properties of ants communication mechanism. ACO(Ant colony optimization) is the generations based algorithm used to determine the problems and optimised solution using local and global best solution. The ant colony optimization mechanism uses the approach of meta heuristic and find the solution based on practical ant movements. [14] ACO has a problem that convergence is slow in nature. In order to tackle the issue, mutation and crossover can be accommodated within the ant colony algorithm. These scenario includes hybrid cloud, multi cloud, and aggregate cloud. ACO provides the efficient mechanism to tackle the problems of cloud where resource optimization is critical.

a. Particle Swarm Optimization (PSO)

PSO in image segmentation plays a vital role in minimizing the Make span and Flow time. Particle swarm optimization procedure uses particles as chromosomes. These chromosomes utilize the properties of their parents. The feature extracted becomes mutated in the mutation phase to yield the best possible solution. Reduce Make span is the problem arises due to aging of the image segmentation. Set of preventive techniques are utilized to prevent this situation. Initially it is necessary to classify the faults occurring within the software system. Analytical approach is applied in order to determine the optimal number of times rejuvenation is required. The accuracy of modelling is determined using metrics such as root means square error, and absolute error

These mechanisms incorporated within energy conservation of sensor could lead to optimize results in terms of lifetime of the network. In addition mechanisms

are iterative that could gives best possible hold out rate meaning more packets could be transmitted towards base station. Next section presents comparison of different protocols indicating best possible mechanism for future enhancement.

IV. COMPARATIVE STUDY OF TECHNIQUES OF ENERGY CONSERVATION

Table 4: Techniques used for energy conservation of sensors

Protocol	Year	Merits	Demerits	Remarks
SLGC[15]	2017	Lower energy consumption in SGLC compared to LEACH	Large overhead due to complex data communication	It is distributed efficient energy consumption and distribution protocol.
CCM[16]	2016	Energy consumed in the selection of cluster head is less as compared to leach	Chain head selection is complex and has more overhead associated with it	Mixture of flat, hierarchical and location based routing is combined
GAF[17]	2016	GAF increase the network lifetime by saving energy Routing fidelity is maintained	Large traffic injection and delay is not predictable	It is a location based least energy consumption protocol
TDEEC[11]	2016	Modified DEEC Clustering protocol provides better performance in terms of energy consumption then DEEC	Slotting is used hence it is more complex	DEEC with time division is considered hence overall operation is faster
LEACH[18]	2015	Every node in the cluster may become cluster head depending upon the amount of energy node possess Collisions are avoided since leach protocol is accompanied with time division multiple access mechanism	Difficult to implement in large networks Lack of uniformity in selection of cluster head	Earliest protocol associated with clustering
PANEL[19]	2015	Panel is energy efficient that ensure load balancing and long network lifetime Supports asynchronous applications	Clusters are predetermined To determine geographic position information, special conditions are needed, which is not always available	This is efficient node selection algorithm for handling cluster
TTDD[20]	2015	Resolve the numerous mobile sinks and moving problem of sink in large scale WSNs Suitable to event detecting WSNs among irregular data traffic	Large latency Low energy efficiency TTDD require sensor nodes to be stationary and location aware	It is a two tier energy consumption minimization protocol
PEGASIS[21]	2015	Uniform load balancing Reduce cluster head selection over head Packet drop ratio decreases	High delays in transmission Scalability is least Time varying topologies make it complex to use	Load balancing is handled efficiently in this protocol as compared to LEACH
TSC[22]	2015	Redundant data is reduced	Asymmetric node balance	Modularity is provided by dividing the network into concentric circles hence better energy consumption is achieved
PASCCC[23]	2014	Priority based data transformati	Energy consumption is high	Priority is assigned but

		on Packet drop ratio is low		starvation problem can be present
SEP[24]	2013	It is better in terms of packet drop ratio	More complex as compared to leach	Energy consumption is less as compared to previous algorithm
LEACH-VF[25]	2010	Solve the problem of area with overlapped sensing coverage and sensing hole In LEACH-VF some nodes can be moved to coverage inside the cluster are	Poor energy efficiency Load balancing is not up to the mark	Area independence is achieved
TEEN[26]	2010	Data transmission can be controlled by varying two thresholds Well suited for time critical applications	Whenever thresholds are not meet , the node will not communicate Data may be lost if CHs are not able to communicate with each other	Hierarchical routing protocol that is used to minimize energy consumption of clustering algorithm
HEED[27]	2009	Routing Scheme used is fully distributed Local Communication is supported for least complexity More uniform in nature High Energy Efficiency and reliability	Communication Overhead is high due to random cluster head selection Extra Energy consumption in selection of cluster head	Better connectivity of cluster heads
EECS[28]	2009	Achieve Load Balancing Clusters are variable in size	Communication overhead is high Energy Consumptio	Energy efficient protocol used commonly at media
			n is exceedingly high	access control layer within data link layer
DEEC[29]	2009	Dynamic node selection Better than Leach in terms of energy consumption	Complex in nature Lifetime can be further improved	Better as compared to LEECH
UCS[30]	2007	Cluster head formed are heterogeneous Variable sized clusters	Limited Implementation framework Residual energy is low.	Commonly used protocol in unequal cluster sized environment
CCS[31]	2007	Least Energy Consumption Packet drop ratio decreases	Asymmetric Energy Consumption Time duration is high	It is network coding based protocol for energy efficiency

From the literature it is concluded that using multi-heuristic algorithms energy of sensors can be increased or prevented from deterioration and lifetime of network can be increased.

V. CONCLUSION AND FUTURE SCOPE

This literature provides the in-depth into techniques that can be used in order to increase the lifetime of the network. To accomplish this objective, multi-heuristic mechanisms can be incorporated within existing protocol such as Distributed energy efficient clustering mechanism. clustering mechanism can be incorporated with priority queue. Packets drops due to aggregation and loss of energy from cluster head can be stored within this queue. The priority of packet can be determined depending upon order in which packet arrived within the system. In addition cluster head selection can be done with multi-heuristic approach to optimize the mechanism of cluster head selection. In future all of the suggested strategies can be tested using the tools of networking like NS3 or standardized tools provided with the help of MATLAB.

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