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IMPROVING CLUSTERING ROUTING ALGORITHM FOR INTERNET OF THINGS PERCEPTION LAYER BASED ON ENERGY OPTIMIZATION

Aamir Hasan, Pt. Ravishankar Shukla University, India (aamirhasan.aamir@gmail.com)
V. K. Patle, Pt. Ravishankar Shukla University, India (patlevinod@gmail.com)
Manisha Chandrakar, Pt. Ravishankar Shukla University, India (manishachandrakar00@gmail.com)

ABSTRACT

In the Internet of Things (IoT), since battery replacement or recharging in sensor nodes is almost impossible, power consumption becomes one of the most important design considerations in the IoT perception layer. For an energy-constrained network, the clustering algorithm is critical for power conservation. Choosing the cluster head will help to balance the load in the network, lowering energy usage and increasing lifespan. This paper focuses on a cluster head election scheme that rotates the cluster head role among nodes. To select the next set of cluster heads for the network, the algorithm considers initial energy, residual energy, and an optimal value of cluster heads. The proposed work has integrated Particle Swarm Optimization (PSO) and Multi-Verse Optimization (MVO) approach with Ant Colony Optimization (ACO) based LEACH protocol. According to the simulation review, the updated variant outperforms the LEACH protocol by increasing throughput, lifespan, and residual energy.

Keywords: IoT, WSN, Energy Optimization, LEACH, ACO, PSO, MVO.

1. INTRODUCTION

Connected computers and artifacts may exchange data via the internet as part of IoT. An impermeable network that detects, monitors, and can be customized via the use of embedded technologies to communicate with one another is being developed. With high reliability and performance, the Internet of Things (IoT) offers instant access to knowledge connected to every computer (Bandyopadhyay et al., 2011). A basic 3-layer architecture (Zhao et al., 2013) present in Figure 1, is chosen from the collection of proposed models. This basic IoT architecture consists of a perception layer, a network layer, and a layer of an application. This research work mainly focuses on perception layer protocol to enhance performance concerning energy optimization.Wireless sensor networks (WSNs) are used to monitor and collect data from a specific region by transmitting it via a wireless network connection. WSNs are self-organizing, have the ability to quickly grow, and have a dynamic network architecture. In the military, industrial surveillance, fine agriculture, and home intelligence they have a broad range of uses. The primary goal of WSN routing research is to develop a routing algorithm that is efficient in the use of node energy, hence extending the lifespan of the whole network. It is divided into two phases: the setup phase and the steady state phase, according to the LEACH adaptive clustering routing method, which is a traditional and low-power adaptive clustering routing technique. The data from the network clusters is gathered, analyzed, and transferred during the setup phase, which is followed by the steady state phase. No promise can be made that the quantity, energy, and location of cluster heads will be distributed uniformly over the field of view. As a result, the cluster heads are picked at random using a probability distribution that has been specified (Singh et al., 2017).

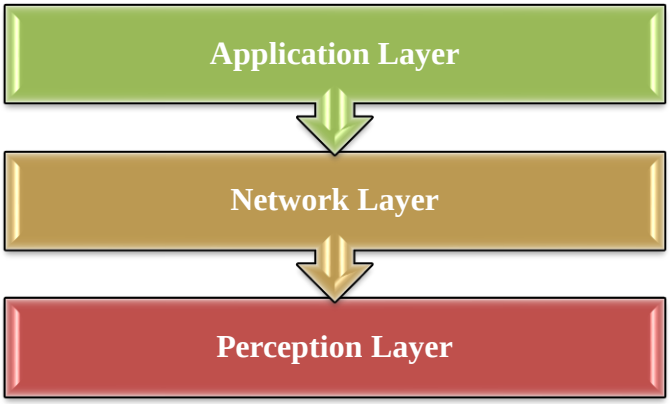


Figure 1: Internet of Things Layered Architecture

5 billion smart gadgets have already been coupled, with an estimated 50 billion devices expected to be connected by 2020. When it comes to real-world interaction, the number of humans may far outweigh the number of robots. In this scenario, there would be a lot of traffic, but only a small percentage of it would be generated and received by people (Lu Tan et al., 2010). Because of the difficulties and possibilities that IoT presents, it is being investigated for different study fields. Wireless Sensor Network (WSN) serves as a conduit for connecting the cyber and physical worlds. Sensing and transmitting values to the Internet is done through tiny sensors or actuators attached. Sensor nodes are installed in the network area to track a variety of physical and environmental parameters in a WSN. Energy-efficient data transmission between sensors and sink nodes or base stations (BS) is necessary since recharging sensors' batteries is practically impossible. For IoT applications, WSNs confront several challenges, including the number of sensors, hardware, communication method (e.g. Wi-Fi or Bluetooth), battery capacity (and computational price), among others. There are extra functionality and new hurdles for sensors in the IoT paradigm when they are employed for more than just sensing (Gubbi et al., 2013). The WSN's primitive protocols and schemes may be improved by embracing several technological developments. Resource depletion, redundant data, network complexity, heterogeneous networks, unstable medium, & the large number of sink nodes or BS complicate QoS requirements in IoT-based WSNs (Bhuyan et al., 2010).Authenticity and secrecy, data privacy, and data freshness are also major WSN security considerations. When building WSNs, reducing power consumption has always been a primary priority. Ideas for lowering energy use and increasing network durability have emerged from the most recent research. The routing algorithm is critical in this procedure. It is possible to establish a hierarchical structure by grouping sensors into clusters or groups and transmitting data to the leader of each cluster (CH). Sink nodes, which operate as a conduit between the end-user and the network, receive the data acquired by the CH and transmit the information to the BS (Heinzelman et al., 2000). LEACH, an energy-conscious clustering technique, has been created. To collect the sensed data, the CH connects with every node in the cluster. Discrimination based on the passage of time CH assigns the multiple access schedules for cluster members. Sending data is a member node's responsibility. It is then compressed and checked for duplicates before being sent on to the sink. Sending data from a CH to a BS consumes more power than sending data from a CH due to the LEACH protocol used by CHs to connect with BSs. This means that they will run out of energy quickly. There are exceptions: multi-hop connections may help, but they are still pointless in small networks. There are several factors to consider while deciding to work with a CH (Chatterjee et al., 2000) When creating a network, issues such as the distance between nodes, the remaining resources, mobility, and the throughput of each node must be considered. In addition to direct or multi-hop propagation, the LEACH approach extends the network's lifespan, but it comes with a slew of drawbacks. The random selection of cluster heads does not guarantee a suitable distribution or a flawless solution. To be voted as CH, nodes of all levels have the same preference as those of higher levels. Since low-energy nodes are chosen to function as CHs, the network cycle may be reduced. CH selection is the focus of this research, which takes into account the initial energy, residual energy of each node, & ideal number of CHs in a network. LEACH method is used to implement change. Using the non-CH nodes' leftover energy, the CH node with a greater level than the others has a better probability of getting picked for the current round. A longer lifetime for the network will result from this.

2. LITERATURE REVIEW

Managing and maintaining a large number of sensors are major difficulties of IoT (Chen, 2012). There is a possibility that replacing sensors' batteries that are still on the network may take a long period. So, for example, the sensor's battery would last considerably longer than the animals themselves if employed on a specific species, making it much more feasible. In addition, this raises the issue of power control. End-to-end data transmissions are also key concerns in WSN (Chonggang et al., 2006).

It is the primary objective of WSN-assisted IoT to provide sensor data to the BS. Direct transfer is the most common method of transmitting data from node to base station or sink node. This is because the node's energy consumption is so high that it will rapidly die out if the distance between the sink & the network is vast. Prior to supplying data to the BS, a clustering approach minimizes the number of resources needed by aggregating network nodes into clusters. CH election mechanism, which ensures that sensor nodes get equal amounts of energy, is an important part of the clustering algorithm. Moreover, the LEACH technique was substantially reworked by researchers. Efforts are being made to increase the accuracy of the IoT approach by the development of new algorithms **(Stankovic, 2014**). Confidence derivation for WSN-assisted IoT network networks was addressed in **(Duan et al., 2014).** Risk strategy research is used to determine the appropriate number of suggestions to avoid network overhead. Network latency may be reduced while still providing enough safety thanks to the energy-aware strategy. According to **(Junping et al., 2008)** clustering is improved by 20 to 30 percent using TB-LEACH, a method of CH selection based on time. A 10% improvement in lifespan is achieved by taking into consideration the distance between nodes and the BS in **(Kang et al., 2012). Thein et al.,** considered the remaining energy in each node. However, only for fixed numbers, the optimal CH value is described in the article. The network's lifespan is extended by 40% to 50%. This research discusses another method of selecting CHs for data aggregation that eliminates duplication and extends the life of a network **(Maraiya et al., 2011).** Depending on how hot a particular sensor node is in comparison to the network as a whole, a hotness factor is used to change the threshold value. Particle swarm optimization is used in (Singh et al., 2012) to choose CH using Particle Swarm Optimization (PSO). There is a definite aim for the selection factors, to achieve. Several network characteristics, including routing protocols, are well-represented in the model. In order to maximize network longevity, (Shankar et al., 2019) makes use of a unique optimization technique known as Clustered Grey Wolf Search Optimization for CH gathering. It was proposed in (Xiangning et al., 2007) that residual energy be used as a primary element in CH selection. After a given length of time, both treatments surpass LEACH in terms of extending life spans. By partitioning the network into zones, (Farman et al., 2018) describes multi-criteria-dependent CH selection. Using the ANP method, choose the CH or zone head. From a collection of parameters, the best parameters for zone head selection were chosen. Researchers have long struggled with figuring out the best methods to install sensor networks while using the least amount of energy possible. In light of the wide range of devices that might be linked to IoT, power consumption becomes a bigger issue. According to the preceding literature, a variety of approaches for selecting the most efficient CH have been discovered. According to our knowledge, important criteria such as the network's optimal number of clusters have not been taken into account while determining CH selection thresholds. Table 1 presents some related works that are already done in the field of WSN-assisted IoT.Kennedy and Eberhart developed Particle Swarm Optimization (PSO) in 1995, and published their findings in 1995. Swarming behaviour such as that seen in birds, insects or fish schools was the inspiration for PSO, in which individual particles are termed swarms and the population as a whole is called a group (or a swarm of particles). The PSO is initialised with a swarm of particles representing a group of randomly selected candidate solutions. The starting location and velocity of each particle are determined. Whenever a particle discovers a path to a food supply, more particles will follow in their footsteps(Kennedy et al., 1995).Ant Colony Optimization (ACO) is an optimization approach that is inspired by the behavior of ant colonies, which may locate the most direct way from their nest to a food supply. Ant Colony Optimization (ACO) is a technique for finding the most direct path from a food source. Dorigo (2004)found this approach in 1990 and published his findings in 1990. During the early morning hours, ants begin travelling from their habitat to a food source by choosing a course at random. Ants leave a pheromone trail on the route they have travelled before returning to their colony and nest. After returning to their residence, the pheromone information is updated in accordance with the rate of evaporation. Pheromones are updated during the optimization process until all ants pick the most comparable path as their preferred route(Dorigo et al., 2004). The EEUC method, which is an uneven clustering technique that employs a temporary cluster head competition radius to form uneven clusters and integrates inter-cluster multi-hop routing to efficiently optimize the energy dissipation of the system of network nodes, has been suggested by researchers. Whenever the cluster size is enormous, however, the conventional cluster head selection procedure fails, resulting in the failure of the cluster

member nodes that are located far away from the base station, resulting in the severance of the inter-cluster communication link Djenouri et al (2017) proposes an energy-aware deployment model of relay nodes (RNs) to address the issue of communication coverage in wireless sensor networks. The model utilised in this article is distinct from current one-tiered and two-tiered models. It assumes the deployment of two kinds of sensor nodes, ERNs and ELNs (ELNs). The goal is to employ solely ERNs for packet relaying, whereas ELNs are only used to sense and broadcast their own readings. A minimal number of RNs are added to assist ELNs. This enables long-term coverage and network longevity. The issue is simplified to the classic MWCDS problem in a vertex weighted graph. The basic form of the weight function is then used to get both precise and approximate answers. To get the optimal solution, we use integer linear programming (ILP) and a heuristic. Upper limits for the heuristic's approximation (to the best solution) and runtime are explicitly determined(Djenouri et al., 2017).

Table 1: Literature Review

S.No.	Author / Year	Basics	Objective of research	Limitation of work
1	**Farman et al.,/2018**.	Wireless sensor network LEACH protocol improvement	Work is considering Multi-criteria for head selection in IoT	No energy efficient solution is provided.
2	**Aditya et al., / 2020**	Internet of Things (IoT) communications may be made more energy efficient by employing green computing technique.	Proposing cluster head selection mechanism for huge WSN	Need to provide more scalable and flexible solution.
3	**Haider et al., / 2019**	Large-Scale WSNs Cluster Head Selection Algorithm with Closeness Centrality	Implementing cluster head selection mechanism for WSN	The research is missing the concept of energy efficiency and optimization.
4	**Altakhayneh et al., /2019**	Cluster-head selection for wireless sensor networks with assistance from unmanned aerial vehicles	Proposing solution for CH selection with help of genetic algorithm	The genetic algorithm is not providing reliable solution.
5	**Lipare et al., / 2019**	In Wireless Networks, Genetic Algorithm Selection of Cluster Heads.	Making use of fuzzy logic for clustering head selection	Work is not providing solution for energy efficiency.
6	**Arulmurugan et al., / 2021**	Using Fuzzy Logic, Cluster Head Selection and Cluster Construction in WSNs are examined in detail.	Work is focusing on energy efficient CH selection	Need to provide energy efficient and optimization mechanism.
7	**Jain et al., / 2019**	For WSN, a Simulated Comparison of CH Selection	Providing energy efficient CH selection	Hybrid optimization mechanism could improve life time of connection
8	**Islam et al., / 2020**	Wireless Sensor Networks Load Compactness and Recognizing Area Aware CH Selection	Work is focusing on recognizing area aware CH selection	Need to provide solution for optimization.
9	**Aalavandhar et al., / 2019**	Reliable CH Selection in WSN is used in analysis of Markov model	Making use of Markov Model for CH selection	Lack of feasibility.
10	**Panchal et al., / 2020**	CH Selection in WSN Using Remaining Energy	Work is considering Energy based CH Selection in LEACH	Lack of accuracy
11	**Bhuiyan et al., / 2019**	In WSN, CH Selection Method	Work focused on cluster head selection	Lack of flexibility.

12	**Kallam et al., / 2018.**	WSNs based on IoT may benefit from multi-criteria zone head selection.	Proposing low energy aware communication	However work is energy efficient but there is lack of optimization.
13	**Shankar et al.,/ 2019**.	CH selection technique for WSN based on PSO	Objective is to propose hybrid model for security aware CH selection	Need to provide more energy efficient solution.

3. PROBLEM STATEMENT

There have been several types of research in relevant fields that have provided cluster head selection solutions. Some of them are not provided energy-efficient solutions while some are not providing solutions for optimization. Existing research did not provide an accurate, flexible, scalable solution. Thus, it has been observed that there is a need to provide an energy-efficient solution by making use of leach protocol since energy optimization is necessary for improving Quality of Service and hence Quality of Experience. Moreover, the use of optimization mechanisms such as ACO, PSO, and MVO could provide a more reliable solution. In this way, a hybrid approach would be used with the integration of ACO, PSO, MVO, and leach protocol.

4. TECHNICAL BACKGROUND

ACO and Leach have been utilized together in this work. These best data transfer routes were discovered by using this hybrid method. Network efficiency and cost-effectiveness depend on the number of sensor nodes in a network as well as the starting energy and communication radius of each node. The number of iterations, the number of active nodes, and the lifespan of each node may all be compared. Communication range and average positioning error; dead nodes; live nodes; normalized network energy; When comparing the proposed model to an existing model, LEACH network coverage, energy depletion, count of data delivery packets, data delivery cost, end-to-end latency, optimum route anticipated energy consumption were taken into account.

Wendi Leach Protocol Adaptive clustering hierarchy was presented by Heinzelman et al. (2020). This is a widely used technique that relies on hierarchical clustering. Rotating the cluster head by chance is used. This guarantees that the energy load is distributed equally across the WSN's wireless sensor nodes. Because of this, the total amount of energy used is lowered. As a result, it has been dubbed the Low Energy Adaptive Clustering Hierarchy (LEACH). LEACH is outperforming static clustering mechanisms by making demand of nodes to volunteer as a high-energy CH and adapting corresponding clusters depending on nodes which could be chosen as CH during specific time period. Different node is having burden of retrieving information from other nodes in corresponding cluster at different time. Data is combined to get aggregate signal. Data is forwarded to sink node at different time. Data could also be transferred to base station. There are several enhancements in efficiency of leach protocol since its invention.

4.1 ACO

Dorigo et al. (2004), introduced Ant colony optimization. This mechanism is depending on optimization mechanism which is based on swarm intelligence. It is making use of the positive feedback as well as distributed computations. These computations are consisting study of collective foraging behaviors of ants. They act in order to search optimal path in different paths that are connecting food source to their nest according to pheromone concentration value. Ants are secreting chemical substance that is known as pheromone. This substance is used to join path among nest as well as food source. ACO are not just finding shortest path. They are also measuring node energy. Network lifetime gets increased with support of this mechanism.

4.2 MVO

MVO is a new type of invention. It is an effective maximization method which gets encouragement from environment. Mirjalili et al. (2016), invented this. For putting this in to operation, two customized factors were kept in mind by them. This method is invented by using three ideology of cosmology. In addition to this form, it also becomes famous in new form of meta-heuristic optimization method. It efficiently figures out those problems which

are related to OPF. It is a method which gets continuous motivation from living body & social science stand point. In working of this method different ideology of cosmology are bring in to use. In addition to idea of white & black hole, concept of wormhole is also used in this method. One of most important strong point of this method is that it will find out fast rate of intersection. For this purpose it use roulette wheel selection. In addition to this, this algorithm is able to deal with regular & discrete optimization issues.

5. SIMULATION RESULT ANALYSIS

ACO with PSO mechanisms has been used in previous studies to simulate route selection. However, MVO is being used instead of PSO as represented in Figure 2. Both are then compared to investigate, the suggested model is expected to have a higher level of performance. The suggested MVO-based work is expected to be faster than the current ACO,PSO model. To see how much time, it takes to run the PSO and MVO algorithms for 5000 iterations, we ran the following simulations using Octave Simulator:

Table 2 Comparative analysis of MVO and PSO based route selection optimization with Hybrid Leach based ACO

	ACO	**PSO**	**MVO**
Time (Sec.)	10.62374	11.117	5.14283

4.1 Flowchart of proposed work

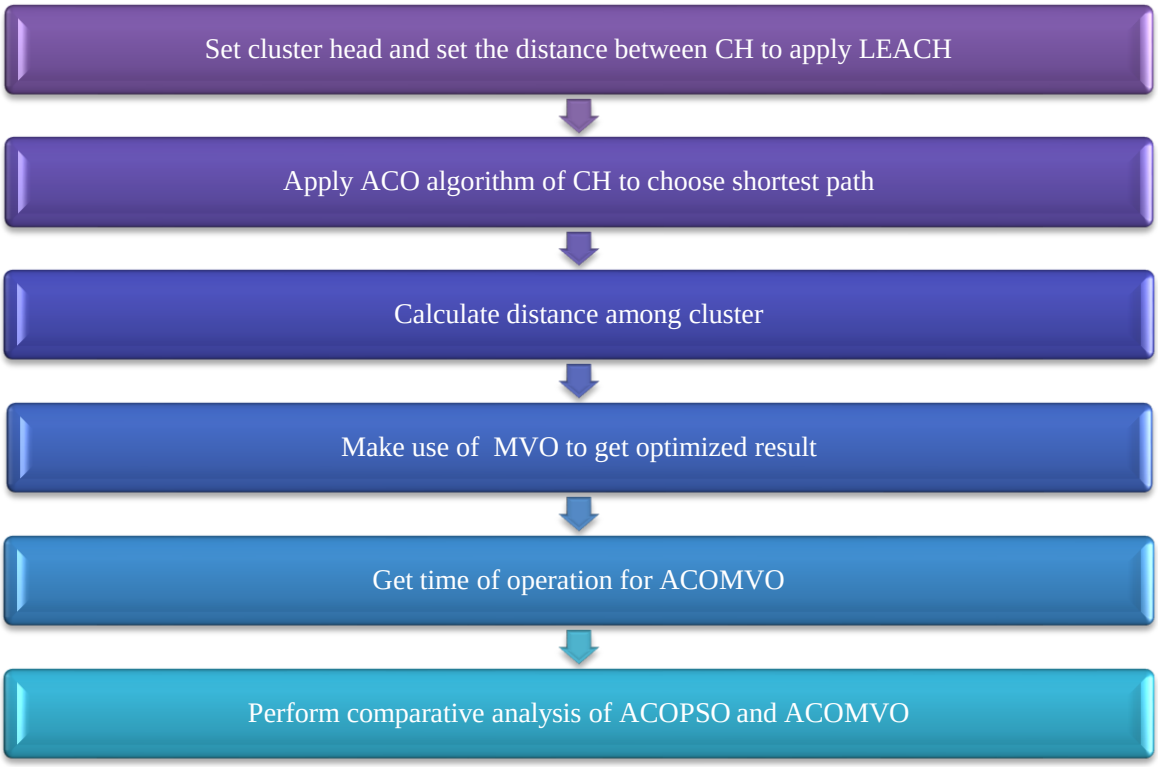
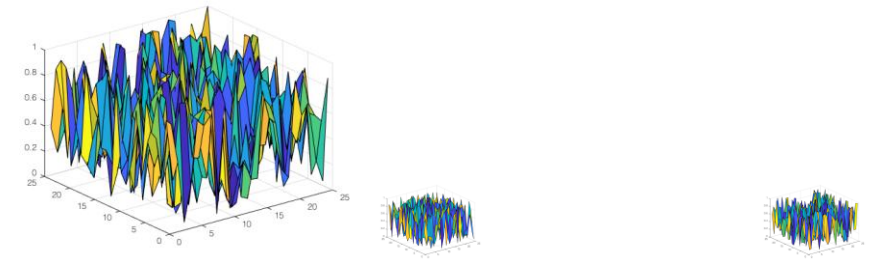


Figure2: Flowchart of proposed work

The graphs in **Figure3**, demonstrates the number of cluster heads with the number of rounds for different distances.



(a) **(b)** **(c)**

(d) **(e)** **(f)**

Figure 3 Histogram of number of cluster for various rounds on various distances

The following data compares the amount of time (in seconds) it takes to run a PSO-based versus an MVO-based experiment. When comparing MVO to PSO, it has been shown to take less time. If the number of iterations increases, so does the amount of time it takes to complete each one.

Table 3: Comparison of multiple iterations of simulations

ITERATION	ACO	PSO	MVO
2000	10.67	11.41	9.85
3000	15.86	16.88	11.29
4000	20.95	21.59	14.93
5000	26.47	27.62	14.03
6000	35.78	36.37	15.57
7000	37.72	38.6	17.19
8000	43.34	43.96	18.57
9000	51.47	52.73	21.35
10000	77.35	78.41	21.36

Using the preceding information in Table 3, the following graph in Figure 4, shows the time spent on the iteration of ACOPSO and ACOMVO.

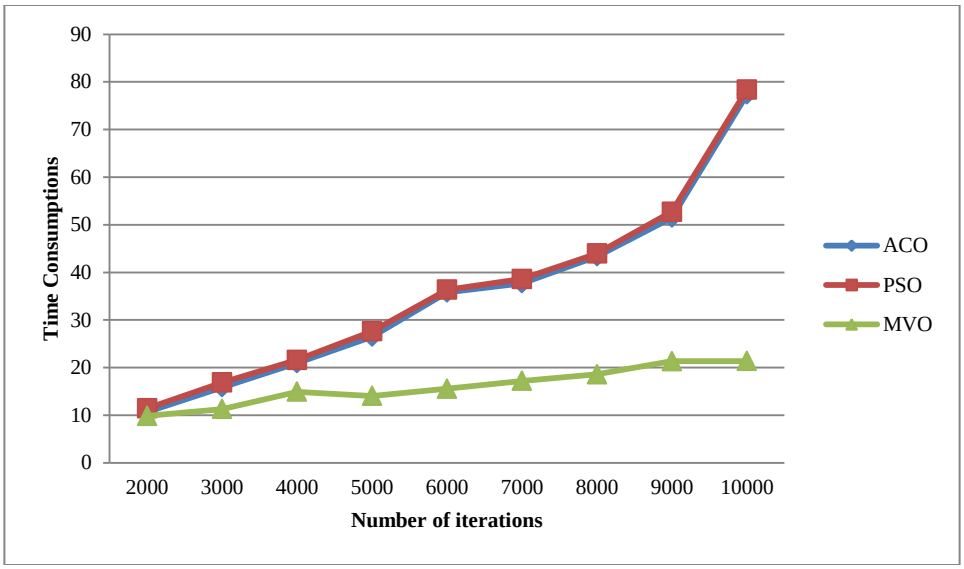


Figure 4: Comparison of multiple iterations of simulations

6. CONCLUSION

It has been concluded that the use of PSO and MVO approach along with ACO mechanism could provide an optimized solution it is concluded by some old optimization technique like PSO and ACO were compared and result is analyzed with this technique. From figure and table, we can clearly see the difference among all of three techniques we can say MVO gives better result.Since energy and lifetime are two main restrictions when developing a routing protocol for a WSN, a lot of studies have gone into it. Energy-efficient routing algorithms that distribute network load equitably are challenging to find. Adaptive algorithms are guaranteed by the LEACH protocol, although there are certain drawbacks to using them. For homogeneous networks, the enhanced routing mechanism is a better option than LEACH, which may be utilized for environmental monitoring utilizing the Internet of Things. The simulation shows better network efficiency in terms of time consumptions i.e., better network lifetime. Research work has also considered basic optimization mechanisms such as PSO. The suggested model may also be evaluated on many practical WSN-assisted IoT scenarios.

7. FUTURE WORK

Present research could be extended in near future by introducing other optimization techniques or methodologies. Future research might improve network efficiency by considering additional factors. Moreover, the upcoming research might use advanced mechanisms for clustering. There are various ways to improve energy of IoT as well as improving routing in future those algorithm and technique can be studied and design some new algorithm for better energy optimization than proposed one. The proposed model may also be tested on a variety of real-world WSN-assisted Internet of Things systems and can study the result of proposed model in different scenario.

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