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Fuzzy C-Means Clustering for Enhancement of Energy in Wireless Sensor Network

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Abstract: ***Wireless Sensor Networks (WSNs) consists of a set of sensor nodes that are deployed in a field and interconnected with a wireless communication network. Each of these scattered sensor nodes have the talents to collect information, fuse that data and path the data again to the sink/base station. To collect data, each of these sensor nodes makes decision based on its observation of a part of the environment and on partial a-priori information. In existing work, they used fuzzy logic technique for the cluster head selection to increase lifetime of wireless sensor network. But they used fuzzy based technique like distance of base station and residual energy for selection of cluster head and sometimes one or more cluster heads are formed in the grid. This increase the energy consumption of nodes as nodes has to send data from multiple cluster heads. In proposed work, we used fuzzy-c means for the formation of clusters. Initially deployed the cluster head in the centre of every cluster in every grid and then we select another cluster head on the basis of residual energy and distance with base station. This improves the network lifetime and improvement in the energy consumption of each node to communicate efficiently. We used MATLAB for the simulation to show that our proposed work is much better than the existing techniques.***

Keywords: ***Wireless Sensor Network, Clustering, Fuzzy logic, Membership function.***

I. INTRODUCTION

Wireless Network is a type of Computer Network that provides communication between a numbers of nodes without having a Physical Connectivity between these nodes. No nodes are connected through a Physical Medium to communicate with each other. Rather they use wireless mediums such as air / atmosphere to transmit the data from one node to another. Commonly used wireless transmission mediums encompass Microwave Communication, Radio Wave Communication, Satellite Communication, and many others. WSN is a sub magnificence of Wireless Networks which have the same working principle but are slightly clever or better compared to the conventional Wireless Networks. A Wireless Sensor Network includes spatially disbursed sensors referred to as Sensor Nodes that senses and monitors the environmental situations at the side of communicating with the other nodes or sharing the data between a numbers of nodes. Wireless Sensor Networks (WSNs) consists of a set of sensor nodes that are deployed in a field and interconnected with a wireless communication network. Each of those scattered sensor nodes have the capabilities to acquire statistics, fuse that data and course the data back to the sink/base station. To collect data, each of these sensor nodes makes decision based on its observation of a part of the environment and on partial a-priori information. As large amount of sensors are deployed in harsher environment, it is vital that the distributed computation need to be robust and fault-tolerant. The identification of event in a wireless sensor network should be done as fast as possible, thus the computations are done in parallel. Here we investigate the problem of design of optimal parallel distributed computational architecture. In distributed system components positioned on networked computer systems communicate and coordinate through passing messages to carry out the specified task. Similarly distributed computation is done on distributed nodes connected over the network with defined computational model. A version of computation is a formal description of a specific sort of computational process. More details about computability theory may be determined. This paper assumes the no reminiscence computational version of sensor nodes inside the architecture for primitive recursive functions. No reminiscence computational model method the sensor node just has registers to store values, every time the sensor node receives any fee from different sensor nodes, it simply computes the characteristic with its personal measured cost and the acquired cost and passes the results to the alternative sensor node(s). Each sensing node has a Radio Transceiver for sending the Information (Transmitter) and receiving the Information (Receiver), an Antenna for providing connectivity to the Network, a Micro Controller for controlling the operation of the Sensor Node, an Electronic Circuit for interfacing with different Sensors and an Energy Source usually a Battery as each element utilizes some form of Energy to carry out its operation [1].

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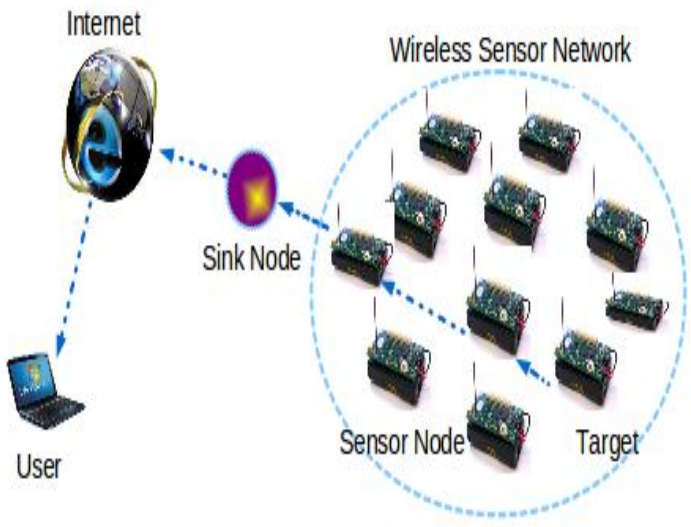

Fig.1. Sensor Network

II. CLUSTERING CLASSIFICATION

Clustering can be classified according to type of data, similarity between two points, and method of defining cluster. According to method of define cluster clustering is classified into below category.

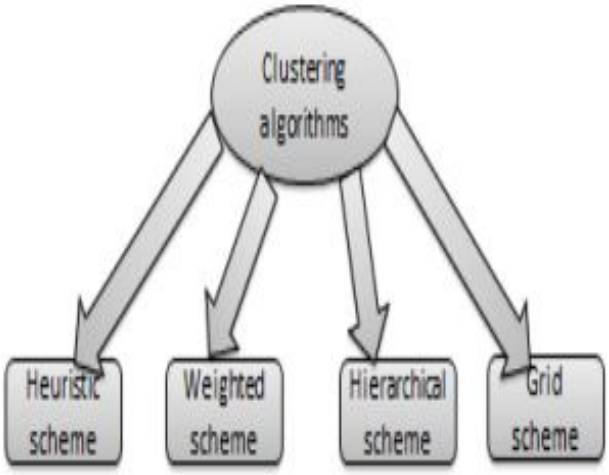

Fig.2 Classification of clustering algorithm

Heuristic based algorithm is used to get optimal number of cluster head. Heuristic research algorithm elects a cluster head one of heuristic clustering algorithm is LCA (link cluster algorithm). In this algorithm each node is having a unique ID number and each node have two different ways for becoming cluster head. First way is that if a node having highest ID within cluster then it becomes a cluster head and in second way; a node makes assumption that there is no cluster head in cluster then it recognizes itself as cluster head. In weighted scheme, the weight of sensor node is defined in line with the position of sensor node, the residual power of sensor node, and the space from sensor node to the base station. Using weight information, better cluster heads can be elected that require less energy for data transmission. In hierarchical scheme; a cluster attribute such as size of cluster and degree of overlap are useful for management and scalability of other nodes.

Power-Efficient Gathering in Sensor Information Systems is a data collecting algorithm that builds the concept that energy savings can result from sensor nodes now not at once forming clusters. Grid associated clustering algorithm is successful to stability power consumption among all nodes in network and extend the network lifetime. This algorithm also maintains traffic from cluster head to its neighbour and cluster head to another cluster head [2].

III.DISTRIBUTED CLUSTERING ALGORITHMS FOR WSN

Distributed clustering is the mechanism wherein, there's no constant relevant CH and the CH keeps on converting from node to node based on some pre-assigned parameters. In this segment, literature survey of numerous posted disbursed clustering algorithms for WSNs is provided, based totally on some advantages like efficient usage of conversation bandwidth inside the clusters, heading off redundant message transfer between the sensor nodes, localizing energy efficient route setup in the clusters, reduction in energy consumption [3], and so forth.

A. Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH is a clustering mechanism that distributes energy consumption all alongside its network, the network being divided into clusters and CHs which are only allotted in way and the randomly decided on CHs, acquire the information from the nodes which can be coming underneath its cluster.

LEACH protocol involves 4 primary steps for each round: Advertisement section, cluster set-up phase, agenda creation and data transmission. In step one, the advertisement section the eligible CH nodes may be issuing a notification to the nodes coming under them to emerge as a cluster member in its cluster. The nodes might be accepting the provide based on received signal strength (RSS). In the cluster set-up phase the nodes can be responding to their selected CHs. In agenda creation step, because the CH gets reaction from the nodes it ought to make a TDMA scheme and send again to its cluster members to intimate them after they should pass the information to it. In the data transmission step, the data collected by the individual sensors will be given to the CH during their time intervals. The main constraint here is that, the radio of the cluster members will be turned off to reduce energy consumption after the data transmission during specific slot is completed. Here in LEACH protocol, multi-cluster interference trouble was solved by means of the use of unique CDMA codes for every cluster.The energy drain is prevented for the same sensor nodes which have been elected as the cluster leader using randomization, for each time CH would be changed. The CH is chargeable for collecting data from the cluster members and fusing it. Finally every CH may be forwarding the fused data to the bottom station. When as compared with the previous protocols (mentioned in section 1), LEACH has proven a sizable development mainly in phrases of power-performance. Hybrid Energy-Efficient Distributed Clustering (HEED): HEED is a distributed algorithm which selects the CH based totally on both residual power and communication price. Basically HEED become proposed to keep away from the random choice of CHs. Though LEACH protocol is an awful lot greater energy efficient while compared with its predecessors (discussed in section 1), the principle downside in this technique is the random choice of CH. In the worst case the CH nodes might not be evenly distributed a number of the nodes and it will have its effect on the data gathering. The HEED protocol receives achieved in three subsequent stages: Initialization segment, repetition phase and finalization segment. Initialization segment, wherein the initial CH nodes percent may be given to the nodes. It is represented by using the variable Cprob. Each sensor node computes its probability to turn out to be CH using equation 1.

$$CHprob = Cprob * Eresidual/Emax \quad \ldots\ldots\ldots (1)$$

Where,

Eresidual - residual energy of the concerned node.

Emax - maximum battery energy.

Since HEED supports heterogeneous sensor nodes, E_{max} may also vary for exceptional nodes in step with its capability and ability. Repetition section, in which until the CH node turned into determined with least transmission value, this phase changed into iterated. If the node can not locate an appropriate CH, then the worried node itself turned into selected as CH. Finalization section, wherein the choice of CH become finalized. In preferred, the tentative CH now becomes the final CH node. Energy Efficient Hierarchical Clustering (EEHC): EEHC is a disbursed, randomized clustering algorithm for WSNs, wherein the CHs collect the facts about the character clusters and ship the aggregated record to the base-station.. Their technique is primarily based on two degrees: Initial and extended. The initial degree which is likewise referred to as single-level clustering, wherein every sensor node announces itself as a CH with a probability p to the neighboring nodes inside its verbal exchange range. These CHs are named as volunteer CHs. All nodes that are inside k hops range of a CH acquire this declaration either via direct conversation or by means of forwarding. Any node that receives that announcements and isn't always itself a CH turns into the member of the nearest cluster. Forced CHs are

nodes which are neither CHs nor belong to a cluster. If the declaration does not attain to a node inside a preset time c language t this is calculated primarily based on period for a packet to attain a node this is k hops away, the node will become a pressured CH assuming that it isn't inside okay hops of all volunteer CHs. In the second level, the procedure is prolonged to allow multi-level clustering and normally builds h ranges of cluster hierarchy. Thereby the clustering technique is recursively repeated at the extent of CHs to form an extra tier. The algorithm ensures h-hop connectivity among CHs and the bottom-station. Assumed that level h is highest, sensor nodes transmit the amassed statistics to degree-1, the lowest stage CHs. The CH at the extent-1 transmits the aggregated data to the level-2 CHs and so on. At the top degree of the clustering hierarchy, CHs transmit the aggregated statistics report to the bottom-station. The time complexity of EEHC is O(k1+k2+…..+kh), which shows a drastic improvement over many O(n) clustering algorithms which include LCA, thereby making it adaptive for network with large number of nodes. Energy intake for network operations consisting of sensor facts collection, aggregated facts transmission to the base-station commonly relies upon on parameters p and k of the algorithm. The values of p and k should be made in such a way that, minimum energy consumption is attained. Simulation results showed that by using optimal parameter values, clustering could be done effectively such that the minimum energy consumption factor is met significantly.

IV. FUZZY LOGIC

Fuzzy related approach is proposed by Lotfi A. Zadeh. There are two approaches consider for clustering: round-robin and fuzzy logic. Round-robin schedules a cluster head to be again cluster head with periodic time interval which is adjustable with homogenous network whereas fuzzy logic provides flexibility of being used in heterogeneous network. Advantage of fuzzy logic related clustering is that it gave decision like human being. It does not allow to system to operate mathematically. If sufficient data is not available at that time fuzzy logic related method work efficiently. Fuzzy logic used partial membership instead of crisp membership. Fuzzy concept is very easy to understand. Fuzzy logic is relevant to natural language. Fuzzy logic is less rigid than the calculation that computer generally perform. Fuzzy logic is fine alternative for many control problems. Features of fuzzy logic are, Smooth noise-tolerant output control function in vast span of input variations, adaptive modifiable governing rules for fuzzy Logic controller processes, simple and imprecise implementation of Fuzzy Logic having low system cost and low complexity and in this various numbers of inputs can be given. Fuzzy related clustering method is unsupervised learning method. Here rules mapping is done in terms of word instead of numbers [2].

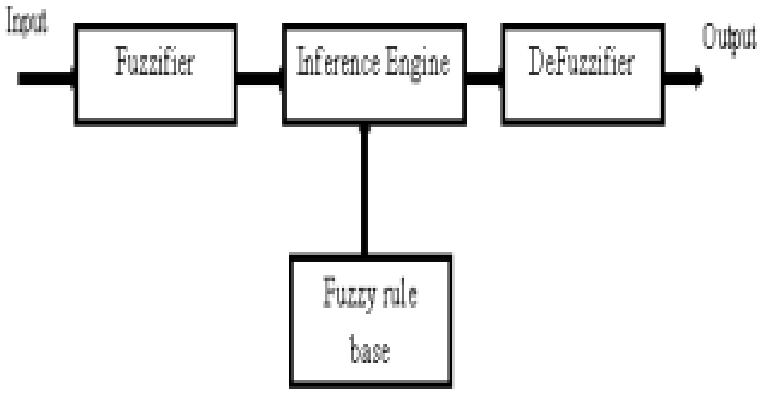

Fig.3. Fuzzy logic controller structure

Firstly input is given to fuzzy system and determines the degree of membership function. Input given to fuzzy system is crisp value while output is fuzzy degree of member ship in linguistic set. Membership function combines a fuzzified input according to rules to build rule strength. In this rules need to combine for getting output. Output is defuzzified for getting crisp numeric fee. The input to defuzzifier block is whole set and output is best single crisp value. For defuzzification, different method like centroid method, maximum method, mean of maxima, extended centre of area can be used.

V. LITERATURE SURVEY

Padmalaya Nayak, et al.[2016] In this paper, our propose a clustering algorithm on the basis of c interval type-2 FL version, watching for to deal with unsure stage selection higher than T1FL model. Lifetime enhancement has usually been a vital problem as most of the WSNs operate in unattended environment in which human get entry to and tracking are nearly infeasible. Clustering is

one of the maximum effective strategies that may arrange the device operation in related manner to wait the network scalability, decrease energy consumption, and acquire extended network lifetime. To conquer over this issue, current researchers have caused the proposition of many several clustering algorithms. However, most of the proposed algorithms overburden the cluster head (CH) at some point of cluster formation. To overcome this problem, many researchers have come up with the idea of fuzzy logic (FL), which is applied in WSN for decision making. These algorithms cognizance at the efficiency of CH, which may be adoptive, flexible, and smart sufficient to distribute the weight among the sensor nodes that can enhance the network lifetime. But unfortunately, most of the algorithms use type-1 FL (T1FL) model [4].

Karthika Sundaran, et al.[2016] we propose an algorithm namely as ECUCF (Energy Conserved Unequal Clusters with Fuzzy logic). Based on the distances of the nodes from the base station, the network is split into three specific sectors. For designing unequal clusters in each sector, a fuzzy logic approach is followed. The cluster heads that are nearer to the base station are designed to be of smaller sizes whereas the cluster heads that are situated farther away from the sink to have higher cluster sizes. The proposed algorithm ECUCF is simulated using MATLAB environment. The performances obtained are compared with the performances of other clustering schemes like LEACH (equal clustering algorithm) and FBUC (unequal clustering algorithm). From the simulated results, it is found that the performances of ECUCF are much improved as compared to LEACH and FBUC in maximizing the number of clusters, increasing the number of live nodes in the network and extending the lifetime of nodes on each round of operation [5].Firoj Ahamad et al.[2016] This paper provides an approach to prolong the WSN lifetime using fuzzy logic based selection of cluster head that provides completely non probabilistic approach. This approach uses two fuzzy variables: Base station distance and residual energy of sensor nodes. In this approach multi-hop communique is used. One cluster Head (CH) has the authority to communicate with the other CH and also with the BS. Simulation result verifies the proposed approach in prolonging the WSNs network lifetime [6]. Pichatorn Eak-Une et al.[2016] In this paper, we propose fuzzy based cluster head selection algorithm (called Fuzzy CHE) to control and maintain cluster size while balance residual energy of sensors and extend the network lifetime. With Fuzzy CHE, each sensor can dynamically adjust probability that each sensor becomes CCH in each round by fuzzy logic. Comparing with existing cluster head election algorithm, results from simulations show that Fuzzy CHE can give more precise control of the average operated cluster size in the network to the deployed size required by the application [7]. Hassan EL ALAMI, et al.[2016] In this paper, we propose a new routing approach referred to as Energy efficient fuzzy good judgment cluster head (EEFL-CH); it's far an improvement of LEACH protocol. The purpose of this technique is to decrease energy consumption in phrases of network lifetime extension using three fuzzy parameters. These parameters are residual energy, expected efficiency, and closeness to base station. Simulation results show that EEFL-CH approach has the better result as compared with LEACH and LEACH-ERE routing protocols [8].

Abdellah NAJID, et al.[2016] In this paper, cluster formation the usage of fuzzy logic (CFFL) method has been proposed to lengthen network lifetime and decrease energy consumption in WSNs. This technique makes use of fuzzy logic within the formation cluster section, two fuzzy parameters are used. These parameters are residual strength which is power level of each CH and closeness to base station (BS) that is the distance. between the CH and the BS. Simulation results show that the proposed approach consumes less energy and prolongs the network lifetime compared with Low Energy Adaptive Clustering Hierarchy (LEACH) protocol [9].

D V Pushpalatha, et al.[2016] In this paper, we propose a cluster head selection algorithm using Type-2 Fuzzy Logic, by considering some fuzzy descriptors such as remaining battery power, distance to base station, and concentration, which is expected to minimize

VI. PROPOSED WORK

WSN includes little sensor nodes with a set of processor and inadequate amount of inbuilt memory units for principle of sensing a variety of types of applicable data from any precise area of environment. Some significant applications of WSN are military, machine surveillance, preventive maintenance, disaster relief operations etc. In this category of network, routing is a little bit more difficult as compared to ordinary wireless or wired networks. The routing protocols those are applied for different types of the other networks cannot be used here because here in WSN, nodes are battery powered. Due to this, WSN should be the energy efficient. Entire network lifetime is depending on proficient energy utilization in sensor network. Clustering is one of the techniques to exploit the energy of network efficiently. This method consumes extra communication overhead in exchanging messes for selecting suitable cluster head. This type of transmission of message from node to node consumes additional energy that makes energy resources inefficient.

In the existing work, they used fuzzy logic technique for the cluster head selection to increase the lifetime of the wireless sensor network. There are two approaches used to select the cluster head which are distance of base station and residual energy. There

multi-hop communication are performed which provide the connectivity of the nodes. But they used fuzzy based technique for selection of cluster head and sometimes one or more cluster heads are formed in the grid. This increase the energy consumption of the nodes as nodes has to send data from multiple cluster heads.

In the proposed work, we used fuzzy-c method for the formation of clusters. Initially deployed the cluster head in the center of every cluster in every grid and then we select another cluster head on the basis of residual energy and distance with base station. This improves the network lifetime and improvement in the energy consumption of each node to communicate efficiently.

A. Proposed Algorithm

Step:1 Initialize the network
Step:2 Divide the network into small area known as grid
Step:3 Deployed the sensor nodes in the network
Step:4 Apply Fuzzy-C means for the formation of clusters
Step:5 Put the cluster heads in the center of the cluster
Step:6 Now we calculate the residual energy and distance for the selection of cluster head in the cluster
Step:7 Collect the data from the other grid members and send data towards the other cluster head or base station
Step:8 Exit

VII. RESULT ANALYSIS

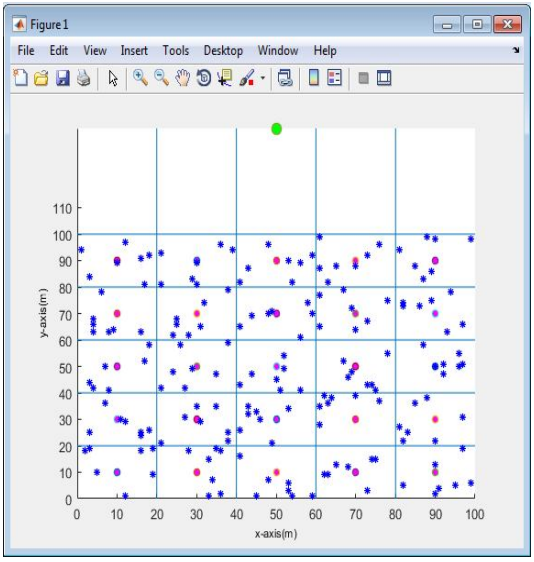

Fig. 4 Deployment of sensor nodes

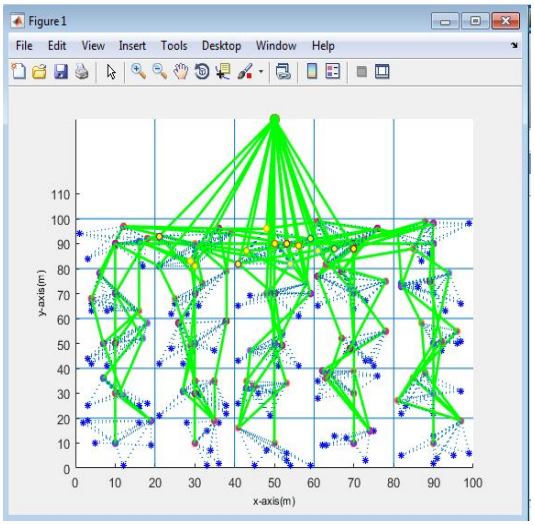

Fig. 5 Sending data towards destination

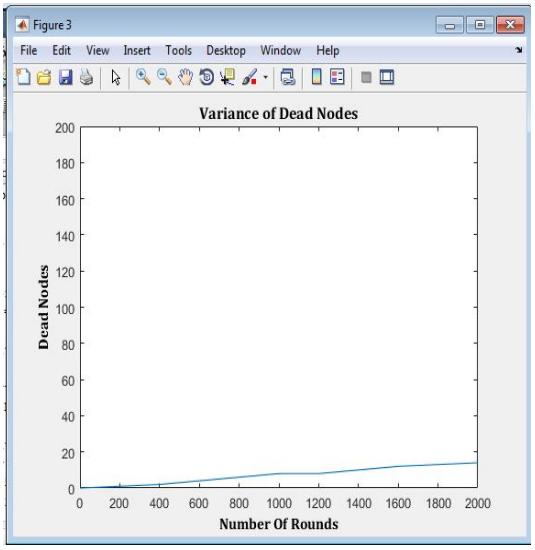

Fig. 6 Number of dead nodes

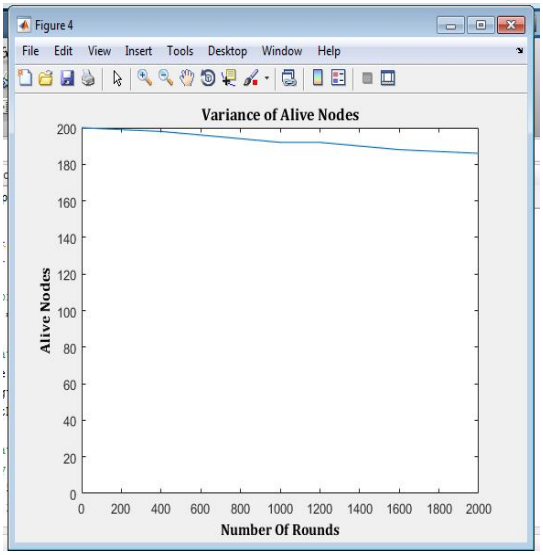

Fig. 7 Number of Alive Nodes

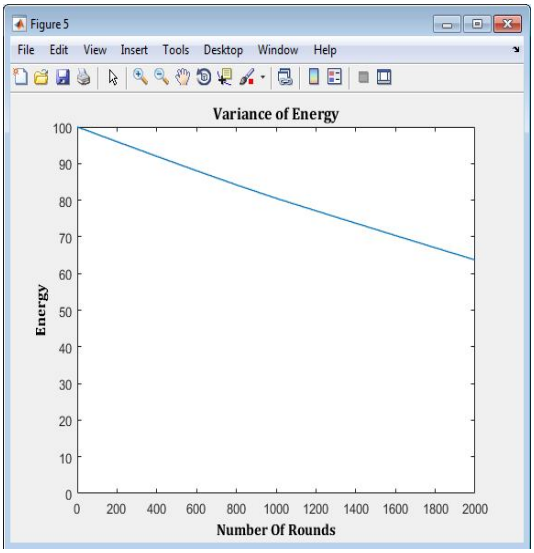

Fig. 8 Lattice of energy at each round

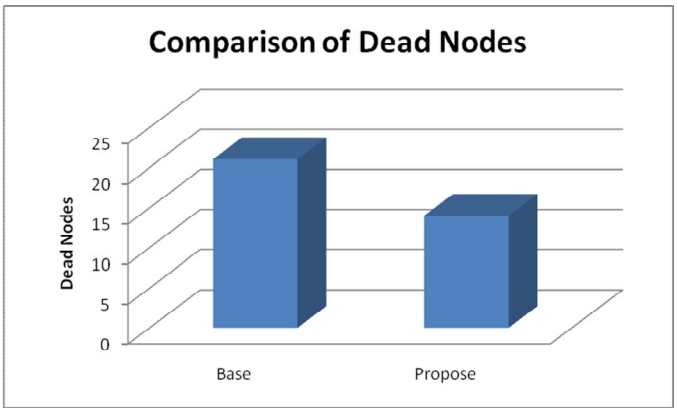

Fig. 9 comaparison of dead nodes between base and proposed technique

VIII. CONCLUSION

Wireless Sensor Network (WSN) that consisting of minute devices that gather different appropriate and precise information by method of co-operating to each other. In this paper we proposed an energy efficient method to extend WSN lifetime which is based on Fuzzy C-Means clustering algorithm. This also determines the bad consumption of residual energy of sensor nodes efficiently with help of suitable cluster head selection method. One of the most important topics in research areas in WSN is to find the appropriate cluster head and forward the data towards the destination. That's especially conquered by way of our proposed technique.

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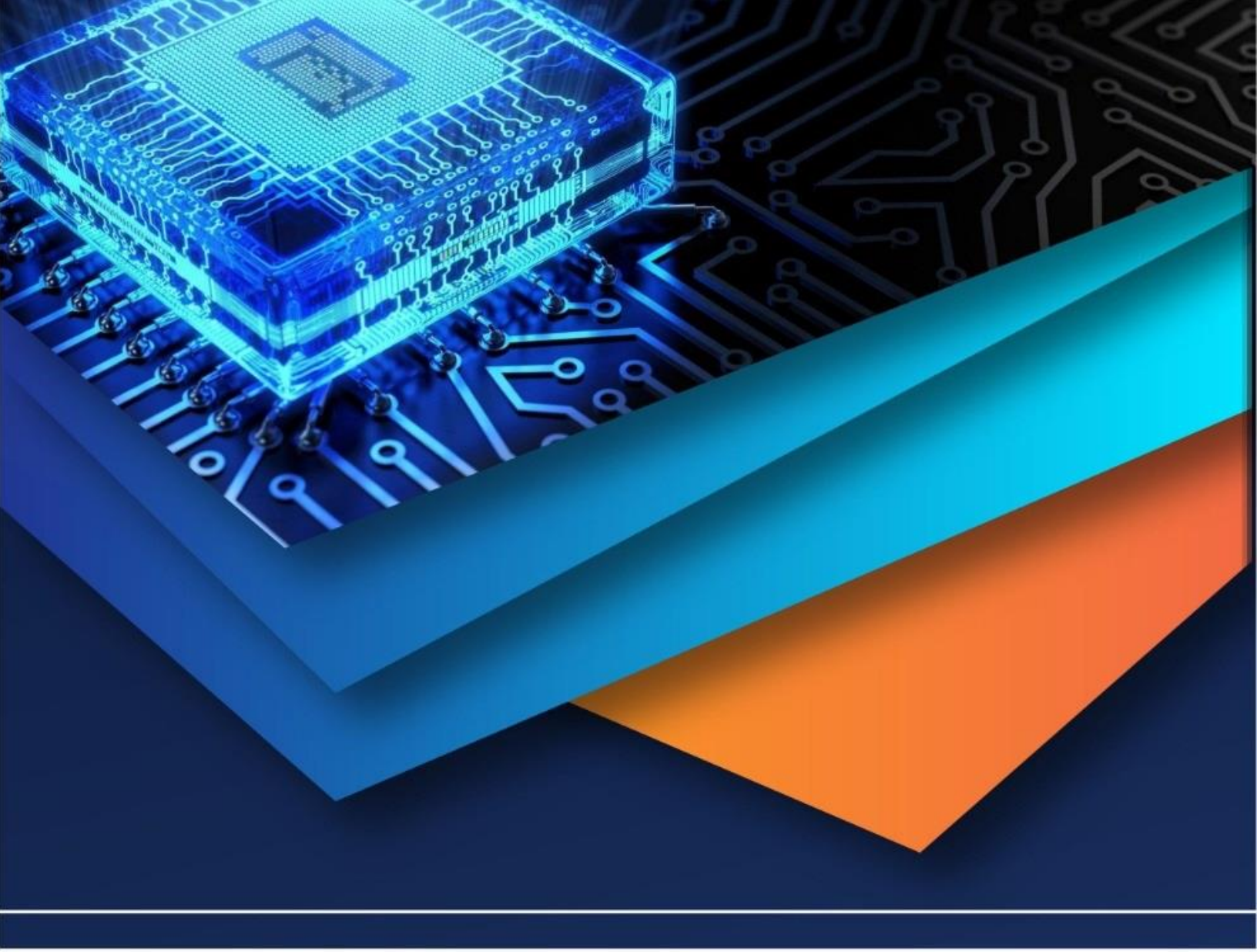

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