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A REVIEW PAPER ON SOFT COMPUTING BASED CLUSTERING ALGORITHM

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ABSTRACT

In past years the Wireless Sensor Network(WSN) has gained high attention in research area due to its different applications like health monitoring, precision diary, military, farming, environment monitoring, fire monitoring in forest ,machine surveillance etc. A WSN consists of tiny sensor nodes which can be deployed in a distributed manner in any harsh environment .The sensor nodes consists of limited resources. With these limited resource the energy consumption should be minimized to prolong the lifetime of the network. To resolve this problem nodes are divided into virtual group according to some rules, which are called as clusters. Each node in a cluster or group can perform different functions. In this survey paper, we provide a view of the soft computing based clustering algorithms and studies made in this area. We analyse the previous work and current existing problems and also point out possible research directions for future work.

Keywords *–* ***Clustering, Soft Computing, Fuzzy logic, WSN, Genetic Algorithm, Sensor Nodes***

I. INTRODUCTION

In this review paper, we have tried to show that gradually the research work has enhanced and shifted from traditional stochastic approach to soft computing/fuzzy logic approach. In earlier times that is in stochastic approach sensor nodes are periodically rotated and assigned the role of cluster head. Gradually it is found that such method is not efficient as several attributes of nodes are not taken into consideration and thereby reducing efficiency. It has been observed that node dying out situation becomes a significant problem in WSN which needs immediate concern. Keeping that fact in view it is submitted by many researchers that if right node is elected as cluster head then this issue can be addressed to a great extent. To elect right node as cluster head, various fuzzy descriptors are used e.g. distance from base station, residual energy, etc. Main reason behind going into Fuzzy approach is making decision even if where there is incomplete information about the nodes. For example a node near to the base station may be used repeatedly and run out of energy whereas other nodes are hardly used. To eradicate this residual energy and distance from base station are taken as fuzzy descriptor to elect the cluster head in each round. To analyse and compare the algorithms several parameters are taken into consideration like time complexity, node mobility, cluster overlap, In-cluster topology, cluster-count, clustering process, CHs selection, CHs rotation, etc.

The Cluster Count refers to number of clusters in the network. The CH election and formation process lead to variable number of clusters.

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The time complexity may be variable or constant depending upon the execution of clustering algorithm. In most recent cases most of the algorithm has constant time complexity, which depends on the number of CHs instead of no. of nodes in the network.

The node mobility refers to whether sensor nodes or CHs are stationary or mobile. If it is assumed to be mobile, the cluster membership of each node should dynamically change.

Cluster overlapping is one of the disadvantage of probabilistic or stochastic approach, which can be solved with fuzzy based RCFAL (grid based) clustering algorithm. Most of the clustering protocol tries to minimize cluster overlap.

The CH selection may be pre-assigned (heterogeneous environment) or calculated in a probabilistic or random way (homogeneous environment) based on the distance, residual energy etc. In the neuro fuzzy system these parameters are taken as input to find the CH.

III. SOFT-COMPUTING TECHNIQUES USED IN CLUSTERING

Soft computing is a promising problem solving technology and in particular it is suitable for unsure and nonlinear problems [6]. In this approach the basic techniques for solving clustering are, FLS(Fuzzy logic system),Genetic Algorithm, Neural Network etc.

FLS-The fuzzy logic system (FLS) is an inference scheme which mimics the human thoughts and its basic configuration consists of a fuzzifier, some fuzzy IF-THEN rules, a fuzzy inference engine and a defuzzifier.

NN-Neural networks (NNs) imitate the human brain to achieve intelligent tasks. They can represent complicated relationships between input and output variables, and acquire knowledge about these relationships directly from the data.

GA-Genetic algorithms (GAs) are numerical optimization algorithms inspired from genetics and have been applied to a wide range of problems . GA typically maintains a population of persons that symbolize a set of candidate key for the considered problem.

IV. RELATED WORK

1.1. RCAFL

The main disadvantage of the most famous LEACH and CHEF like clustering algorithm is that it selects the cluster area depending upon the chosen cluster head which consumes huge amount of energy in the communication process between the nodes. Firoz Ahamad,Rakesh Kumar presented [4] a paper in IEEE International Conference on recent trends in electronics information communication technology,2016.In the proposed scheme the network area is divided into fixed small subareas called grid. It uses two fuzzy variables i.e. base station distance and node residual energy to calculate the cluster head.The result shows that RCAFL protocol prolongs network lifetime in terms of number of rounds. Fig 1 shows the diagrammatic representation of grid based clustering of sensor nodes.

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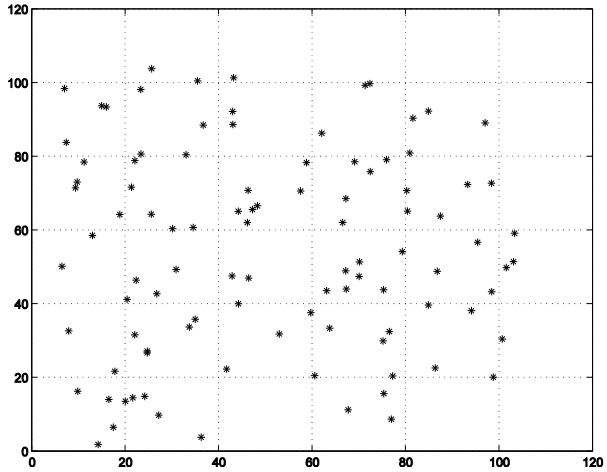

Figure1 Grid Based Clustering Approach

1.2. CHEF

Wireless Sensor Networks (WSN) are real time embedded systems which have limited and specific computation task. So it makes use of in built energy which is limited in nature. Hence reducing consumption of such energy is prerequisite to increase network life time and thereby increase efficiency of WSN. It is found that appropriate use of cluster-head election methodology can reduce the energy drastically [3]. In this algorithm it is proposed that depending on network configuration a substantial increase in network lifetime can be achieved than through probabilistic/stochastic selection of nodes. Accordingly a fuzzy logic based approach has been made on three descriptors namely energy, concentration and centrality. As cluster head does the significant portion of entire work, appropriate cluster-head selection can increase the network lifetime by reducing energy consumption. In real time there may be some instances where decision need to be taken even if there is no complete information. In this situation crisp logic or traditional logic approach fails whereas Fuzzy logic fulfills the requirement. Hence selecting fuzzy logic in cluster-head selection is a prudent decision.

1.3. F-MCHEL

This algorithm is an enhancement of LEACH protocol. Hence the base protocol is LEACH with a little modification. Tripti Sharma and Brijesh Kumar in their paper titled as "Fuzzy Based Master Cluster Head Election Leach Protocol in Wireless Sensor Network" [5] observed that in traditional LEACH protocol much energy is dissipated in communication made between each cluster head and the base station. So network life time is of poor quality and moreover depends on all the cluster head. In order to improve the issue they proposed to elect the cluster heads based on Fuzzy Logic taking into consideration two descriptors namely energy and proximity distance. This step was taken to improve the cluster head selection and thereby only the most suitable nodes are elected as cluster head. Second step was to elect a Master Cluster Head from the Cluster Heads based on their residual energy. By this step they intent to reduce the energy consumption by electing a master cluster head which is only authorized to communicate with base station. This makes the process independent of energy concern of all other cluster heads. The cluster head having maximum residual energy is elected as Master

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Cluster Head. Here it is needless to mention that this uses a multi-hop communication. As we know multi-hop communication uses less energy than direct or one-hop communication. Also simulation has proved that appropriate Master Cluster Head election has drastically improved the network lifetime however the election itself has some energy overhead but it is worth considering the improvement caused in network lifetime.

1.4. LEACH WITH FUZZY DESCRIPTORS

In traditional LEACH (Low Energy Adaptive Clustering Hierarchy) approach cluster heads are rotated periodically to balance the energy consumption. The demerit in this approach is as probabilistically cluster heads are elected so there may exists that cluster head near to base station has already exhausted its energy whereas distant cluster heads are having significant energy. This makes the entire cluster a dead one because of few nodes and specifically due to wrong methodology. Also another problem associated with this is in traditional LEACH approach which work purely on crisp logic, decision cannot be taken if information are not complete in all respect. To improve the above said issues, Jin Shyan Lee et al.[1] proposed that LEACH can be improved by using Fuzzy Logic instead of Crisp one. So few fuzzy descriptors can be taken to elect Cluster Head and thereby the first issue can be addressed. For example by taking residual energy into consideration in electing Cluster Head, the energy dying out situation can be handled efficiently. Similarly in centralized Cluster Head selection approach every decision is to be taken by base station as it collects all clustering information and decide the cluster head, thereby energy consumption is huge. By taking proximity distance as fuzzy descriptor this issue can be well handled.

1.5. LWTC-BMA

In traditional LEACH approach as discussed earlier stochastic method is used in selecting cluster heads irrespective of the efficiency of that cluster head. So there are many nodes which are elected as cluster head but does not perform well, hence wastage of resource. In the current algorithm Rashmi Ranjan Sahoo et al. [2] proposed that if a check can be introduced before election of a cluster head by looking at its past history then efficiency can be ensured. So they introduces a system which computes that whether the node is malicious or benign one. If so it is rejected. A threshold trust value is set. If the node passes the test and secure a trust value more than the threshold value then it is elected to be a cluster head. So the node which performed less efficiently in the past rounds there probability of getting elected in future get diminished. Simulation shows that this algorithm outperformed LEACH and TCBMA in terms of energy loss.

1.6. PSO-BASED CLUSTERING

Particle Swarm Optimization is an optimization technique in which natural species social behaviors are considered for computation. In this system nodes are grouped based on their attributes. For example according to the distance the closer nodes are formed into one cluster, thereby that cluster can balance the energy consumption. It uses a fitness function to test the fitness of node to be eligible for the swarm. It is one kind of heuristic approach. In the last algorithm elimination method is used to elect cluster head. But here selective method is used to fulfill the purpose. Hence resource utilization is optimized in this method by reducing the

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wastage of nodes. That means if a node is not suitable for a cluster it does not mean that it is rejected from the entire network, it may be suitable for other cluster which is formed by combining its peripheral nodes. Simulation results show that PSO based clustering is much more efficient than other mathematical and heuristic approach.

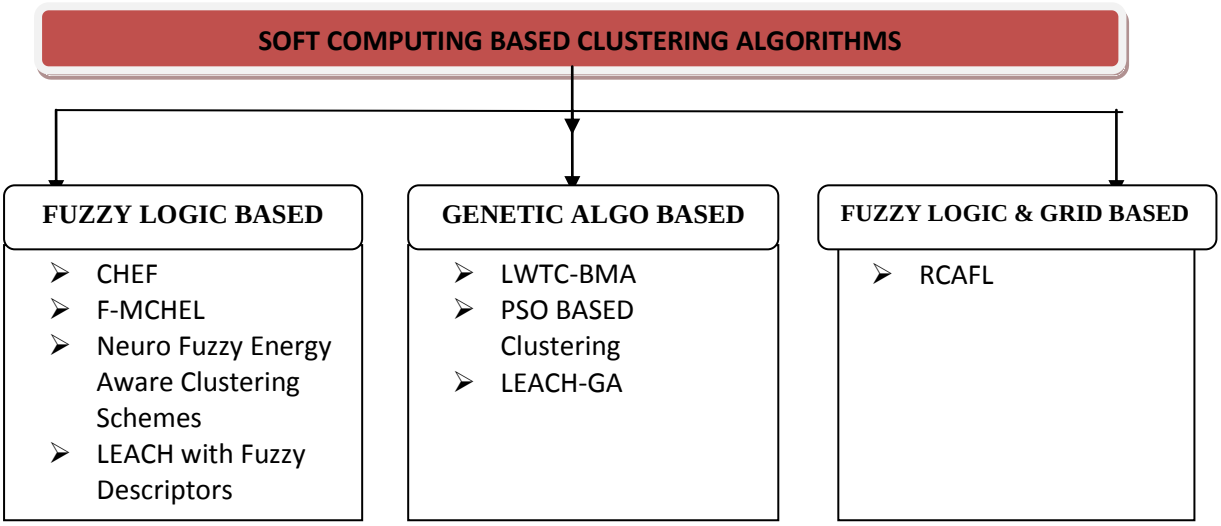

Figure1: Soft Computing Based Clustering Algorithms

III. COMPARATIVE STUDIES OF CLUSTERING ALGORITHMS

Table-1 Comparative Study Of Different Algorithms Based On Different Parameters Described In Section-1.

Clustering Approaches	Time Complexity	Node Mobility	Cluster Overlap	In-Cluster Topology	Cluster Count	Clustering Process	CHs Selection	CHs Rotation
RCAFL	Variable	Limited	No	1-hop	Fixed	Distributed	Preset	Yes
CHEF	Variable	Minimal	Yes	1-hop	Fixed	Distributed	Based on energy, concentration, centrality	Yes
F-MCHEL	Constant	Limited	Yes	Multi-hop (sensor => cluster head =>	Fixed	Distributed	Based on energy, proximity-distance	Yes

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				master cluster head => base station)				
LEACH with FUZZY DESCRIPTORS	Constant	Minimal	Yes	1-hop	Fixed	Distributed	Based on any fuzzy descriptors	Yes
LWTC-BMA	Variable	Limited	Yes	1-hop	Fixed	Centralized	Based on past history of nodes	Yes, subject to it perform s well in last rounds
PSO-Based Clusteri ng	Variable	Once	No	1-hop	Fixed	Hybrid	Proximity Distance	Fixed

IV. CONCLUSION

Wireless sensor network is a revolutionary invention in the field of computer networking and automation. Looking at its importance in various field several efforts have been made by many research scholars of the field. Among the various methods of improving the efficiency of WSN, clustering is one. In this review paper we made an effort to compare the above mentioned algorithms on the basis of said parameters and tried to find out the trend which has been going on in the field of clustering technique. On comparing above algorithms we arrive at conclusion that clustering technique has shifted from probabilistic model to soft computing or fuzzy logic model. As described above fuzzy logic is the need of time. Clustering using fuzzy descriptors, GA and

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other soft computing techniques has proved to be efficient especially when information from the network is incomplete. Moreover using the above soft computing techniques has saved significant energy wastage and enhances the longevity of the network. From the above study we find that there is cluster head (CH) selection in each round irrespective of its requirement or in spite of an already available efficient CH in the previous round. Hence the proposed future work is developing "on demand selection of CH" and introducing it in the clustering process. Last but not the least the concept of AI may be introduced in the clustering process.

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