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Energy Efficient Concentric Clustering Protocol for Wireless Sensor Network

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Abstract— Energy Efficiency technique plays an important role in saving the energy. To improve network lifetime, an efficient data aggregation protocols which help to eliminate redundant data transmission in a wireless sensor network must be in place. In this paper the concentric clustering where each node sends data to the CH. The CH aggregates and sends it to the BS via co-ordinate nodes. Cluster head is selected using K nearest neighbour algorithm and DRAND time slot for data transmission. This approach consumes a minimum amount of energy. The drawbacks of existing protocols are listed and compared with the proposed protocol.
Keywords—Concentric clustering, Co-ordinate nodes, Energy efficiency, Combined rating, Heterogeneous wireless sensor network.

I. INTRODUCTION

This "Wireless" term is used to describe the communication where electromagnetic waves carry a signal over the path. Wireless sensors can be deployed all over the surface on the earth. It uses battery power to communicate with each other and the battery in the wireless sensor cannot be charged once deployed. Wireless communication is used in business and personal computing. Sensor networks and Ad-hoc are parts of the wireless communication. Wireless technology such as Cellular network and wireless LAN uses infrastructure based communication whereas in ad-hoc network the communication between nodes takes place without any fixed infrastructure [2]. Wireless sensor network consists of nodes. Nodes in the wireless sensor network are equipped of smart sensors so it is called as "Sensor" [2]. Sensor node senses the data like temperature, pressure, vibrations into user recognizable data. Wireless sensor network is less mobile than the ad-hoc network. In wireless sensor network sensors are randomly scattered in the network field. These nodes have the ability to collect the data and route it in the network to the sink. The data are routed to the end user by muti-hop infrastructure less architecture to the sink as shown in the figure 1. The user can retrieve the data from the sink via internet.

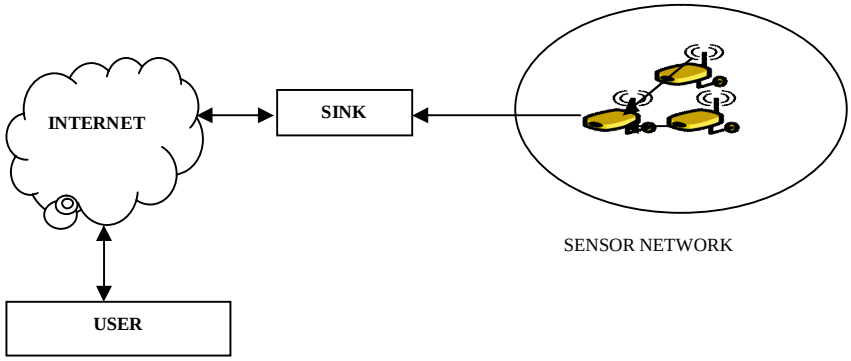


Figure.1 Typical Wireless Sensor Network Architecture [1]

Now in recent scenario the growth of wireless communication is vast. Because the wireless technology can be applied in any kind of situation it has a capability of reaching in any part of the earth surface. Now considering the recent market scenario in which there are a lot of wireless products are available. There are so many wireless network are there some are infrastructure based and some are infrastructure less. Ad-hoc and wireless sensor network, cellular network are some example of wireless network [3]. In wireless sensor network each node can process and sense the data as well as can communicate with other nodes. Then the sensed data is sent to the central processing unit(CPU). Sensor nodes are small device that consists of low power signal processing, a short range communication capability, a micro sensor and low power communication. As in the figure 2, the hardware components of sensor network composed of memory, sensors, radio transceiver, power source and embedded processor. The four components are

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described in the figure below [4].

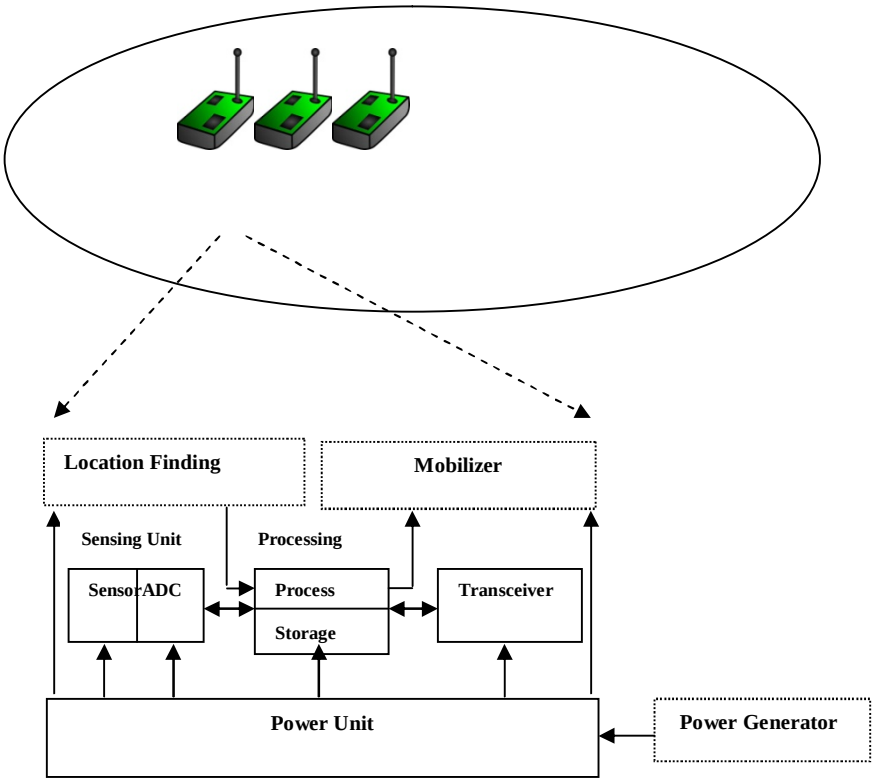


Figure2 The components of a sensor node.

A. Applications In Wireless Sensor Network

Wireless Sensor Networks consist of different types of sensors such as low sampling rate magnetic, seismic, visual, thermal, acoustic, radar and infrared. Sensor nodes monitor various types of ambient conditions such as humidity, noise levels, lightning condition, pressure, vehicular movement or motion, temperature, soil makeup [7].

Tracking

Monitoring

II. RESEARCH SURVEY

A. Definition Of The Problem

Designing of energy efficient level based protocol for wireless sensor network.

B. Theoretical Background Of The Problem

The Routing protocol plays an important role in wireless sensor network topology for exchange of information, for location the destination node and for selecting the route for data transmission. To have an efficient protocols various routing factors and the type of network has to be selected.

Depending on the applications of the wireless sensor network and functions there are different types categories as below [5].

Proactive

Reactive

Hybrid

Proactive protocols route the information automatically and independently. On demand based the reactive protocols react immediately. Hybrid protocols are combination of proactive and reactive protocols. There are three main techniques, they are flat,

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location-based and hierarchical protocols. In all these hierarchical routing protocol plays a very important role in energy conservation. The figure.3 shows the classification of hierarchical routing protocol, where some of the protocols are being displayed such as leach, pegasis, heed, teen, apteen and so on [6].

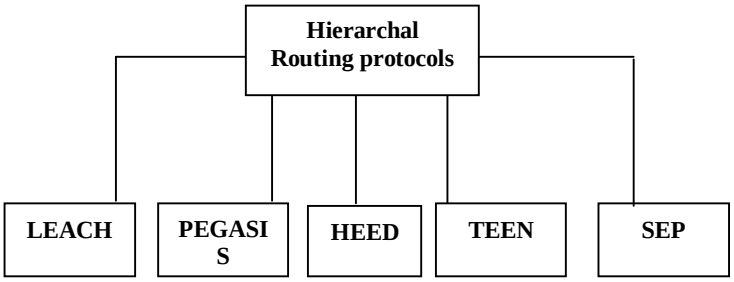


Figure.3 Classification of Hierarchical Routing Protocols

C. Energy Efficient Concentric Routing Scheme (Eecrs)

This protocol distributes the sensor nodes in every cluster depending on the energy dissipation of each CH. As the result of simulation the energy of the cluster head is dissipated constantly. Here the energy is distributed over the network. This protocol increases the efficiency of data aggregation by decrease in the data size. The EECRS calculates the value of weight for cluster head selection. This weight is inversely proportional to the square of distance from the CH [8]. Sensor nodes transmit the data to each cluster heads according to chains. The CH at the end transmits the data to the next cluster head. Then the cluster head aggregates the data in the same cluster and transmits it to the next CH until it reaches the base station. The figure below shows the data transmission.

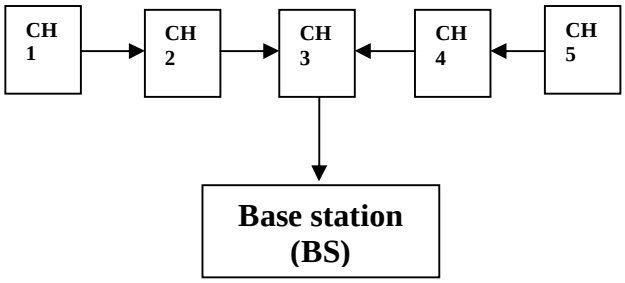


Figure.4 Formation of chain

D. Comparative Analysis Of Different Techniques Used In Literature

TABLE I
COMPARISON OF DIFFERENT PROTOCOLS

Protocol / Parameters	LEACH	PEGASIS	TEEN	APTEEN	HEED
Routing	Cluster Based	Chain Based	Hybrid	Hybrid	Cluster Based
Node Mobility	Fixed BS	Fixed BS	Fixed BS	Stationary	Stationary

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Data Aggregation	No	No	Yes	Yes	Yes
Energy Efficient	No	Yes	Yes	Yes	yes
Balanced Clustering	OK	N/A	Good	Good	Very Good
Cluster Stability	Moderate	N/A	High	High	High
Multi-hop	No	No	Yes	Yes	Yes

III.PROPOSED WORK

A. Concentric Cluster Module

The sensor network field is divided into levels where each level is a concentric region. Each region in the field consists of nodes with the base station at the centre. The figure.5 shows the various levels and the base station at the centre [9].

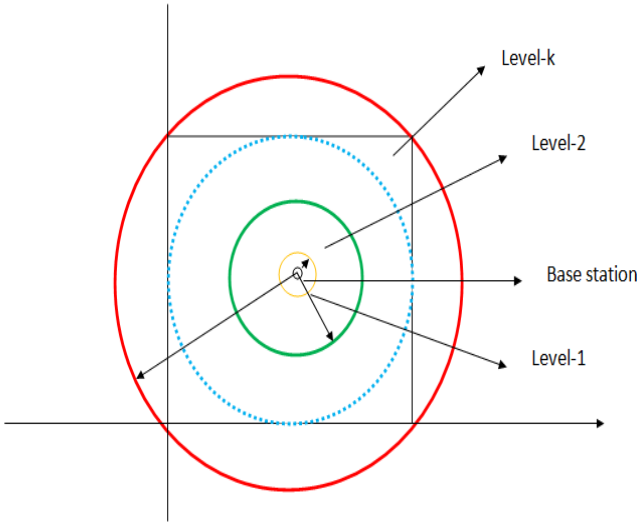


Figure.5 Concentric cluster formation

All the nodes and the base station are fixed in the area. The topology of this network remains same. The base station is situated at the centre of sensor network area. The nodes energy is distributed in the network. The base station sends the Hello packets and gets the location of all nodes. The nodes are checked for the energy higher than the threshold value. If the nodes greater than the threshold value, it is selected as co-ordinate nodes. These nodes will send the location of itself to the base station acknowledgement. The Base Station sends the information regarding the respective co-ordinate Node to the specific region. [8]. The flowchart for creation of concentric cluster is given in figure.6.

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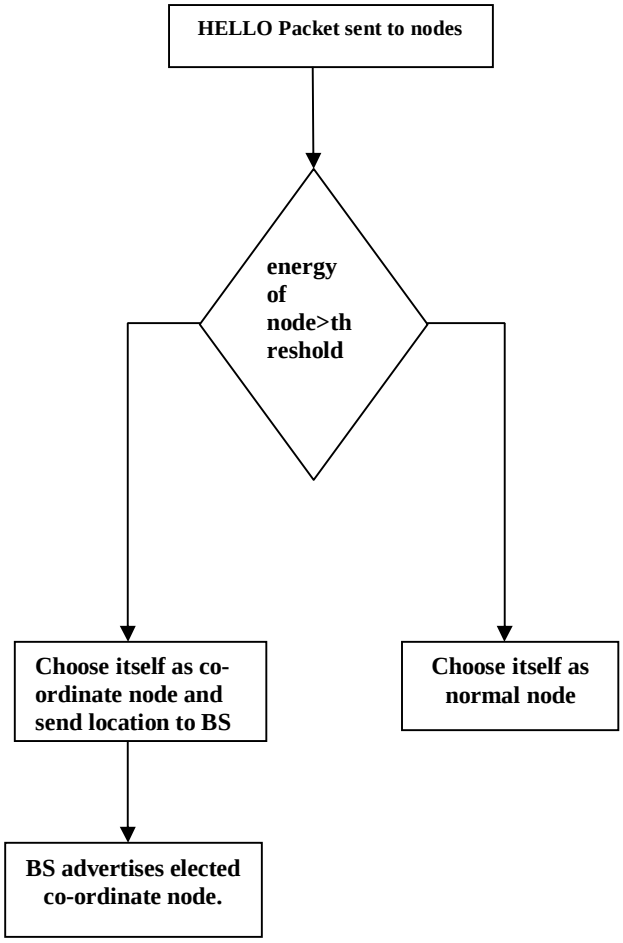


Figure.6 Flowchart for creation of concentric cluster

B. Cluster Head

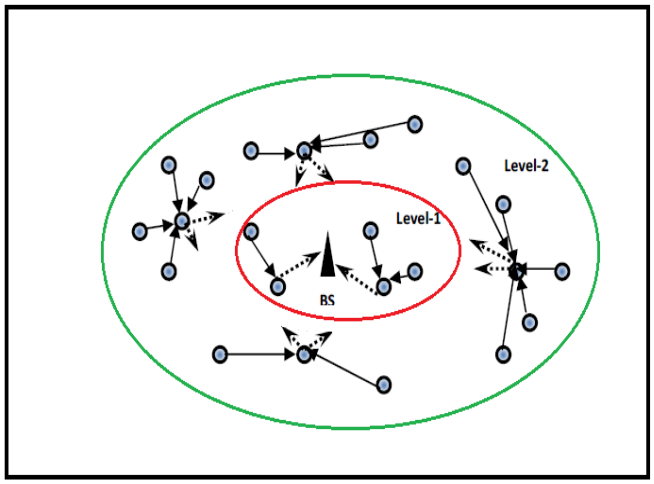


Figure.7 Formation of cluster

As in the above figure.7 the cluster heads are formed in each levels. The sensor nodes senses the data and transmits it to the base station. The nodes which are at level 1, near to the base station will directly sends the data to the BS.

K-theory is used for selection of cluster head. Here the nodes sense the data.

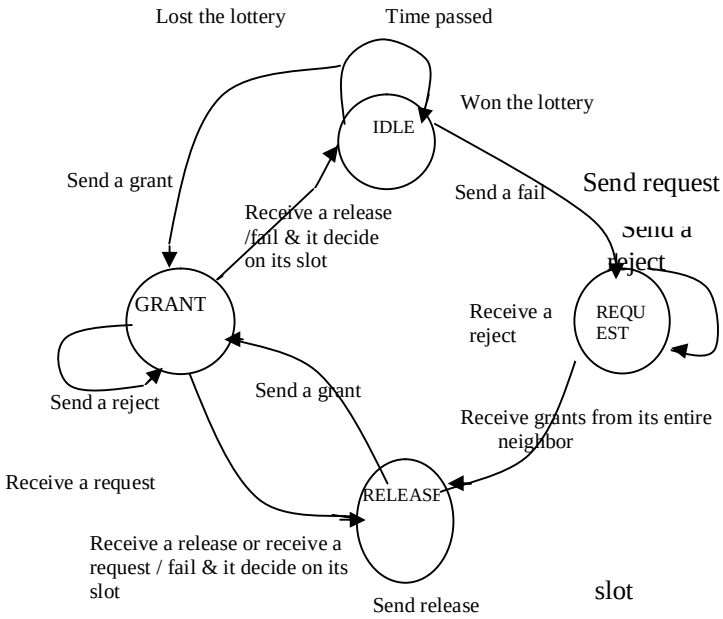
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Step1: According to the density of the nodes in cluster, co-ordinate node sets the value of k for each round. It is broadcasted to each clusters (k is the number of nearest nodes).
Step2:The nodes in the cluster send k nearest neighbors to the co-ordinate nodes. The distance between nodes is calculated by received signal strength indicator (RSSI).
Step3: Based on k-theory, now candidate set of cluster heads will be selected.
Step4: These candidate set is requested to calculate their combined rating (CR).
Step5: Each node calculates the CR based on the distance to co-ordinate node, residual energy.
Step6: Then the cluster head is selected by the co-ordinate nodes among the set of candidate nodes. Highest CR possessing node will be selected as cluster head and it will be informed to all the nodes in the cluster.
Each cluster head uses DRAND TDMA scheduling for data receiving and transmission. Each time the cluster head is selected based on its residual energy and dissipation of energy compared to the previous round. If residual energy is not twice of the energy dissipation then co-ordinate nodes will reselect the cluster head.

C. Creation Of Concentric Cluster

Initially base station located at the corner of a network broadcasts hello packets to all the nodes in the network. The co-ordinate node which has energy greater than the threshold energy sends back acknowledgement packets to the Base Station which includes unique id, its energy and location information. Initially when the first co-ordinate node is encountered we draw an imaginary boundary thus forming a first concentric cluster. Similarly while encountering other co-ordinate nodes similar concentric circles are formed. Thus the entire region is divided into n number of concentric clusters depending upon the number of co-ordinate nodes. Co-ordinate nodes are used to transmit data either single hop or multi hop. The region between the base station to the first co-ordinate node encountered and the region between the subsequent base stations are classified as individual clusters. All the nodes in a cluster send data to cluster head which aggregates the data and send it to the base station. The co-ordinate node then forwards this aggregated data information to the base station for processing [9].

D. DRAND Time Slot



DRAND runs in rounds. If no neighbour have sent request then the node will be in idle or release state else turns to grant state. After a node gets the request from its neighbour it turns to request mode. Receiving grant from its one hope and two hope neighbours it

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will be released as shown in the above figure.8 [9].

IV. RESULTS

A. Parameters Used For The Simulation

TABLE III
PARAMETERS

Network size	100X100m
Base station	(50X50)
Number of sensor nodes	100
Initial energy	0.05J
Eelec	50nJ/b
Emp	10pJ/b/m^2
EDA	5nJ/b/signal
Data packet size	4000bits
N(levels)	6

The parameters are set which are used for simulation of the proposed protocol. The above table displays the parameters used. The levels of clustering are set to 6. There are 6 clusters in the simulation and other parameters are set as above.

E. Comparison Graph

Here the simulation for new protocol is carried for 100 nodes and the graph is tested for various numbers of rounds. The comparison of EECRS and the proposed protocol is given below with varying dead nodes vs round number.

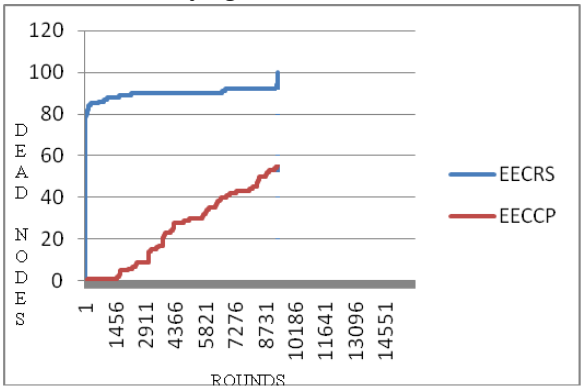


Figure.9 Protocol comparisons for dead nodes

The above figure.9 indicates the number of dead nodes increases based on the number of rounds. All 100 nodes in the EECRS are dead at 9377 round and only 57 nodes are dead in the proposed protocol. Hence the proposed protocol is more efficient then the existing protocols. The data packets transmitted to the base stations is showed in the figure below. The figure.10 shows the packet to the BS vs number of rounds. At round 731, 16000 packets are sent to the base station in proposed protocol whereas in EECRS only 7000 packets are sent to the base station.

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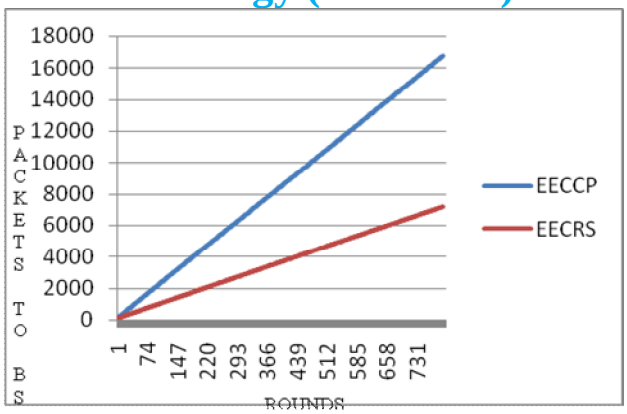


Figure.10 Packets to the BS

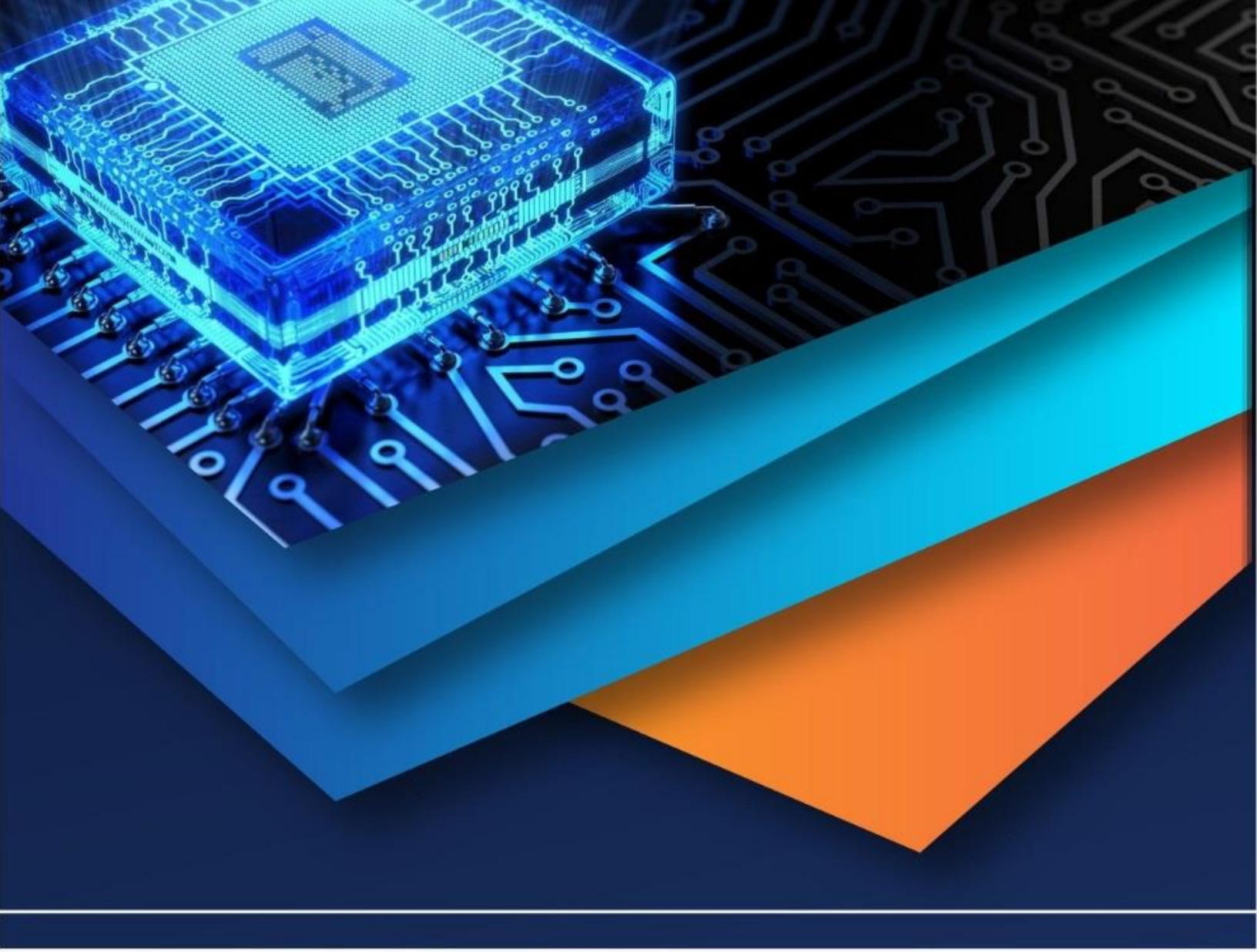
V. CONCLUSIONS

By using the concentric clustering technique for clustering and K theory for cluster head selection an energy efficient protocol is designed which has good stability and lifetime compared with previous protocols in the wireless sensor routing protocols.

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