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MINIMIZING MOBILITY FOR DATA AGGREGATION IN CLUSTER BASED RFID NETWORK

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Abstract: *RFID (Radio Frequency Identification) network is used for sensing and tracking the objects. The main flaw in this network is reader collision which leads to redundant data. Consequently, due to dissimilar mobility between a head and its member nodes can cause unstable clustering. Hence, the protocol known as Dragonfly based Clustering Protocol (DCP) is proposed to minimize the frequent cluster breakage and to improve the data transmission in the network. The reader with high residual energy level and lower mobility is picked as an eligible cluster head. After picking the eligible head, the distance, speed and neighbour count values are calculated between the head nodes and its neighbours. The values are added and optimum cluster heads are opted if the calculated value is high. Then the other nodes join the cluster based on the movement of the head. The conclusion shows that optimal cluster heads are opted using DCP than LEACH in which mobility is not taken into account in picking the cluster head. The simulated result in NS2 shows that DCP protocol selects optimal cluster head and the cluster breakage is low when compared with LEACH protocol. The reading efficiency in RFID network is also improved using DCP clustering.*

Keywords- Clustering, Data aggregation and RFID Networks.

1. INTRODUCTION

RFID technology is used for identification of objects. It is used for collecting data on objects for tracking in a cooperative environment. The system is composed of tags and readers in which reader is combined of the transceiver and antenna where the RFID tags are combined of transponder transmitter and antenna. An object has a microchip that performs as a tag. Information about the objects is stored in tags. Readers are used to sense the data from tags. The reading efficiency of the reader decreases is the key problem in RFID system. Reading a same tag multiple times by different readers leads to redundant data. Forwarding the redundant data to the base station decreases the reader efficiency.

The redundant data leads to different issues in data management and processing techniques [1]. Thus, aggregation of data is a method used to remove the redundancy present in the cluster by aggregating the duplicate packets in the network [2]. Due to speed and movement of the nodes in the network, frequent failures of link occur. Nodes are away from one cluster to different clusters before transmitting the data which leads to routing issues in the network. The paper focused on how to clear up the redundant data in RFID network. In some routing protocol, each reader collects the data and forward directly to the station which decreases the efficiency or the readers. Cluster scheme is used for improving the reader efficiency in RFID network. Readers are selected as head and the remaining readers and tags join the cluster. Each reader sends the data to the head and the head aggregates the data before forwarding to station.

In existing system, LEACH (Low-Energy Adaptive Clustering Hierarchy) protocol is used for cluster formation. In this, heads are picked randomly depend on the probability value [3-4]. This leads to frequent cluster breakage before forwarding the data to the base station. In firefly algorithm, heads are picked based on energy and mobility of the readers in the network where remaining nodes joined the cluster based on the head mobility. Collision between the nodes in the cluster is not considered which causes more redundant data in the network.

Energy efficient clustering using the dragonfly algorithm is proposed to improve the reading efficiency in multiple-reader RFID system. The dragonfly clustering scheme has two stages. In the first stage heads in the RFID network are selected based on the potential score such as the mobility and energy of the readers in the network. Remaining readers join the best effective cluster based on mobility of the cluster head. Each reader controls a distance between other readers to avoid collision. All the readers move closer to cluster head for effective data transmission within the cluster.

The rest of this paper is organized as follows. Section 2, reviews some clustering schemes in RFID network and Section 3 explains the problem statement. Section 4, presents the system architecture of the RFID network. Section 5 explains our DCP clustering protocol and Section 6 presents some simulation results. Finally, in section 7 we conclude our paper.

2. RELATED WORK

Vivek Chandran et al., [5] proposed a Dynamic Energy Efficient Latency Protocol for eliminating the redundant data in the network. Reading the same by multiple readers leads to redundant data. To resolve the redundancy problem an aggregate tree is built for a given size of the sensor network. Locality Sensitive Hash code is used to avoid the data duplicates and the false data based on similarity. During each cycle, the code is produced for each sensor nodes after data reading from the tags in the network and passed to the aggregation supervisor node. Redundancy count for similar LSH code is maintained by aggregation supervisor to select only one sensor node among nodes to send actual data.

Heinzelman et al., [6] presented a **LEACH** (Low-Energy Adaptive Clustering Hierarchy) protocol used for clustering the readers and tags in the network for effective data transmission. In LEACH, picking head in the cluster is done randomly using the residual energy of the readers in the network. In this protocol, the performance is improved by evenly dissipating the energy of the nodes. Energy factor is considered for picking cluster head. This protocol is limited since the mobility point is not examined for head node selection. Due to absence of mobility, the cluster breakage is frequent in LEACH protocol. As this protocol does not consider the mobility of the readers after choosing the head within a round, the protocol is faces serious data losses in wireless network. The breakage of the cluster is high in this protocol.

Victoria Bueno et al., [7] proposed an algorithm Geometric Distribution Reader Anti-collision (GDRA) for dense RFID systems which are particularly used to avoid reader collision. The collision issue is classified as reader-to-tag and reader-to-reader collisions. Collisions may reduce the achievement of the network and decreases the count of identified tags each time. The is a centralized approach for scheduler that accomplishes the probability function of geometric distribution to reduce the collision. GDRA provides high throughput for reader environments.

Hiren Thakkar et al., [8] proposed a routing protocol called Multi Hop Communication Multi Level Data Aggregation (MHML) to solve the frequent cluster selection issue. The MHML protocol picks the node as a head which has high residual energy to prevent the entire network to die too early. Cluster head removes the duplicates of the data by aggregation before forwarding to the BS. The aggregated data is transferred to the base station in Multi-Hop transmission Multi-level data aggregation way. The communication distance between the nodes is reduced due to Multi-Hop communication and the packet size is reduced due to Multi Level data aggregation. Thereby, the energy efficiency is gained and the signal failure is reduced.

Younis et al., [9] proposed a Hybrid Energy Efficient Distributed Protocol (HEED) protocol to structure the clusters to increase the lifetime of nodes. In this protocol, possibility the of power levels at sensor nodes are take into assumption. However, it does not consider about the deployment of sensor nodes or about node position-awareness. Head selection is based on two values such as the residual energy and node proximity to its neighbours. In HEED, heads are randomly choosed on the basis of the residual energy. Therefore, HEED cannot assure optimal election, in the form of energy because the other parameter resolves conflicts. Also, inter cluster communication of the nodes in the network has not been taken in HEED.

Bala Krishna et al., [10] proposed an approach called cluster based data aggregation. In this approach, network is organized in cluster form based on sensor nodes for data aggregation. Data is aggregated locally at the head to eliminate the duplicate data in the network. Node failure problem which causes transmission delay and loss of data is solved using the cluster technique. Clustering protocol operation such as head selection phase and transmission phase is performed in each round in the network. In the head picking phase, choosing the head based on centralized or distributed manner and then clusters are formed. In steady phase, the head collects the data from the nodes inside the cluster to perform aggregation on the received data and then transmit fused information to BS node. EEBCDA solves the problem of energy dissipation in homogeneous cluster based sensor network. The network is divided into swim lanes and swim lanes are further into unequal size rectangular grids. The CHs are selected in distributed manner based on residual energy of the nodes in the network. The CH among the node rotates in each grid respectively. The CH forwards the data to BS by single hop communication.

3. PROBLEM STATEMENT

RFID provides information for the application in real-time in an efficient manner. The readers may be densely deployed, so the detection range of the RFID readers overlaps, which produces a lot of redundant data and limits the large-scale implementation. The redundant data must be cleaned before the original data is sent to the high-level applications. The redundant data in the RFID systems can be divided into two categories namely, the redundant reader and the redundant tag data.

Redundant reader belongs to spatial redundancy, which means that the detection range of the readers overlap spatially and result in redundant data. In this type of redundancy, readers are densely deployed, all the tags in the detection range of a reader be read by at least one other reader. Same tag will read by multiple readers. Same data will be read multiple times by the reader in the network.

The redundant tag data belongs to temporal redundancy, which emphasize that a tag is read many times by the same reader, thus a large number of duplicate records emerge in the network.

In a wireless sensor networks, a leaving node means a node that come away from its parent head before a new selection of cluster head. The leaving rate becomes high, when the difference of the mobility of the head and the members are large. The outcome of the mobility on the rate should be reduced. In RFID networks, the number of leaving readers leads to reader tag collision which is the major problem. In the reader tag collision, same tag information can be read by multiple readers due to the mobility. It leads to redundant data in the network system. It is avoided by selecting the head based on the mobility, speed and the energy. The readers with high residual energy are opted as an eligible heads. From the eligible heads, mobility factor is considered to select the optimal cluster heads which reduces the leaving rate. After choosing the cluster head, the remaining readers joined the cluster based on the mobility of the cluster head.

4. SYSTEM ARCHITECTURE

Each reader and tag contains potential score such as similarity of mobility and residual energy as shown in the figure 1. Residual energy is the remaining energy of the readers in the network. All the readers in the network send their energy level to base station. Base station determines the average residual energy level among all the readers. The average energy is set as threshold value which varies dynamically based on the energy of reader. The readers with high residual energy are picked as an eligible cluster head. Mobility is also choosed to select optimal cluster heads for reducing frequent cluster breakage before data transmission.

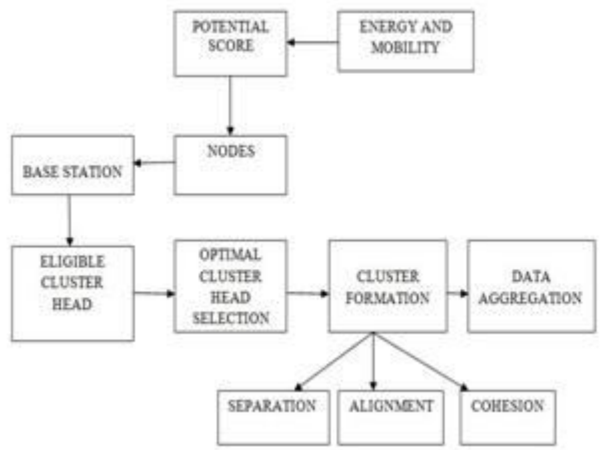

Figure1: Cluster head selection and formation using DCP algorithm.

Eligible cluster head must have minimum mobility. Otherwise the head move away from the cluster before collecting the data from other reader in the network. Readers with high residual energy and minimum mobility are selected as optimal cluster heads. After the cluster head selection, the distance is between the cluster head and neighbour nodes are calculated

5. DRAGONFLY CLUSTERING PROTOCOL

Energy Efficient cluster head picking scheme for data aggregation should minimize the node mobility in RFID networks. Optimal cluster heads are selected and redundant data is eliminated by data aggregation at the head. In this part, we have introduced our new clustering protocol known as "Dragonfly Clustering Protocol (DCP)". The first part in this describes the method of choosing the head and cluster formation. The second part explains how aggregation of data is performed in the RFID network.

DRAGONFLY

Dragonflies are the fancy insects. There are almost 3000 different species of this kind are found in the globe. Dragonflies are small predators, in nature it hunt many small insects in the world. Nymph dragonflies hunt other marine insects. This type of species also hunts small fishes. This is the unique and rare swarming behaviour about dragonflies when compared with other insects. Dragonflies swarm do two process such as hunting the prey and migration from one swarm to another. Dragonflies can be static or dynamic in nature. Static swarm is known as feeding swarm and dynamic is known as migratory swarm. Dragonflies form small cluster over a small area and fly front and back to hunt other flying

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preys such as mosquitoes and butterflies. It create sub-group at multiple areas to hunt the prey. The main aim of any swarm is survival in the world, so all of the dragonflies move towards food sources and separated from enemies.

5.1 CLUSTER HEAD SELECTION

Cluster structure can maintain the lifetime of the RFID network. The heads are picked inside the clusters to avoid the energy dissipation from all nodes. Each reader broadcast hello text to its neighbours. All the readers which are within the communication range receive the hello text and acknowledge the sending reader as its neighbour. By this, each reader can know its neighbours in the network. The heads are choosed considering the potential score such as energy and mobility. Each reader energy level is compared with the value of threshold. Threshold value can be defined as the residual energy required for receiving data from all readers, aggregating the data sent by readers and sending it to the BS. The reader with high residual energy level is compared to its threshold value is selected as eligible cluster head. Among the eligible cluster head, optimal heads are elected using Dragonfly Clustering.

Dragonfly algorithm uses three primitive principles:

• Separation refers to the collision avoidance of one reader from other in the neighbourhood. For separation, the distance of the eligible cluster head and neighbours are considered.

• Alignment indicates mobility matching of eligible cluster head to other readers in neighbourhood of the network. In this direction and speed of the readers are taken into account for the selection of heads.

• Cohesion means neighbour count of each eligible cluster head in the network.

The readers and tags are mobile in the network. By considering the dynamic behaviours of the readers in the network, there are three main factors used in position updating of nodes in the network such as separation, alignment, cohesion.

Each of the factors is used for optimal cluster head selection as shown in figure 2.

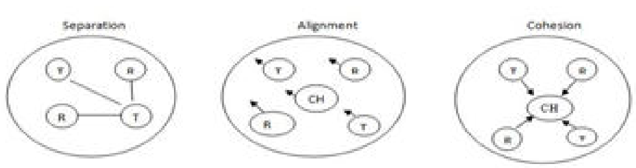

Figure2: Techniques used in the dragonfly algorithm.

The behaviours are mathematically modelled as follows:

Separation: After the eligible selection of cluster head, the distance of the cluster head and its members are calculated. The distance is calculated to determine all the nodes are near and to improve efficiency of reading in the RFID network.

The separation is calculated as follows:

$$S_i = \left(\sqrt{(x2-x1)^2+(y2-y1)^2}\right)/N \qquad (5.1)$$

Where (x1, y1)is the place of the current reader or tag,(x2,y2) shows the place of the neighbouring node and N is the number of neighbouring readers among the current reader.

Alignment: After the separation, the reader and tag nodes that are neighbours to cluster head join the cluster considering the mobility of the cluster head. The movement of cluster head must be similar to neighbour readers to form the cluster to avoid cluster breakage in RFID network as illustrated in fig [4]. The mobility for each reader is calculated using alignment.

The alignment is calculated as follows:

$$A_i = \left(\sum_{j=1}^{N} Vj\right)/N \qquad (5.2)$$

Where Vj shows the mobility of j-th neighbouring node in the network. After the alignment is calculated, the direction and speed of the cluster head is selected.

Cohesion: Once the alignment process is completed, the neighbour count is calculated for the eligible cluster heads. Neighbour count refers to number of nodes around the cluster head. If the count is less then the effective clustering is affected. So the count must be high for improving the efficiency in the network.

The cohesion is calculated as follows:

$$C_i = \left(\sum_{j=1}^{N} Xj\right)/N - X \qquad (5.3)$$

Where X is the place of the current individual, N is the number of member nodes and Xj shows the place of the j-th neighbouring node in RFID network. The separation, alignment and cohesion values are added for each cluster head. The highest value eligible head is selected as cluster head. The head is optimally picked on the basis of less mobility, highest neighbour count and distance.

5.2 CLUSTER FORMATION

Once the optimal cluster head is selected, the remaining readers and tags form the cluster based on the head mobility. The movement of head and members must be similar to avoid the frequent cluster breakage in the network.

Algorithm for cluster head selection and cluster formation:

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Step 1: Initialize the readers and tags in the network R_i (i=1,2,3,...n)
Step 2: Set the potential score (energy and mobility) to each reader and tag nodes.
Step 3: Sending the energy level of the Reader to Base Station and find threshold value.
Step 4: if (Residual Energy (R_i)> Threshold value)
Step 5: Update the node as Eligible Cluster Head
Step 6: else
Step 7: Update the node as Remaining node in the network.
Step 9: Separation is calculated for eligible head in the network using Eq. (4.1)
Step 10: Alignment is calculated for head in the network using Eq. (4.2)
Step 11: Cohesion is calculated for eligible head in the network using Eq. (4.3)
Step 12: Add the values of separation, alignment and cohesion
Step 12: If the value is high set as "Optimal head"
Step 13: else "Become ordinary readers" in the network.
Step 12: Cluster formation is done.

The pseudo-code for the cluster head selection and cluster formation using Dragonfly is presented in the Algorithm. The algorithm finds the optimal cluster head by considering the potential score of the readers in the RFID network. The Separation, alignment and cohesion techniques are used in the algorithm for effective cluster formation in the network.

5.3 DATA TRANSMISSION

After picking the head and cluster formation, all the readers start the signal transmission for sensing the data. The cluster head inside the cluster schedule the readers to sense the data. TDMA schedule is used for scheduling the readers inside the cluster. Based on the schedule, reader sends the signal to tags in its range. After sensing the data, reader sends the data to cluster head. Then the next reader starts its transmission. Once all the readers complete the data transmission, data aggregation is done in cluster head.

5.4 DATA AGGREGATION

Aggregation is a well known technique for avoiding energy dissipation when transmitting the data from cluster head to multiple sinks. When each node performs data transmission to the sink, the energy level for all nodes in the network is decreased. To avoid that, clustering scheme is used. All the readers inside the cluster will send the signal to the tags to sense the information. All the sensed information is sent to cluster head. The major problem in RFID network is the reader tag collision. In this, same tag will be read by multiple readers. Therefore cluster head contains the redundant information so its energy is reduced drastically. Therefore the redundant information must be removed before data transmission to the base station. Aggregating the data is a method used to avoid the duplicate data. When each reader sends the information to cluster head, it is compared with the existing information sent by previous reader. If the information is not same then cluster head store that data else the data is discarded. Once the data aggregation inside the head is done, the data is transferred to base station.

6. SIMULATION & PERFORMANCE EVALUATION

The network environment is designed and implemented using Network Simulator (NS-2.35) [12]. The simulator runs the dragonfly clustering protocol for picking the head and cluster formation to reduce the cluster breakage and to improve the reading efficiency in the network. In our network, there are three kinds of sensors such Readers, tags and cluster heads. All the readers are homogeneous but perform different tasks. This type of distribution balances the operational load within each cluster and also results in improved network lifetime. The cluster head schedules data collection time in the network. Readers sense the data from tags and send to cluster head within the cluster. Cluster head performs aggregation of the gathered data before forwarding them to the BS. Our simulation result is evaluated in parameters such as network lifetime of active readers and head selection. The network simulation and the dragonfly algorithm parameters are defined in Table 1.

Table 1 Network simulation parameters

PARAMETER	VALUE
RFID network dimension	1000 x 1000 sq. meters
Base station location At	(800,800)
Number of Reader nodes	(20)
Number of Tag nodes	(60)
Transmission power (etx)	12.910 watts
Reception power (erx)	11.081 watts
Initial node energy	150 joules
Packet Length (m)	14 bytes
Sleep power (esp)	0.00214 watts
Routing protocol	AODV Protocol
Total simulation period	800 seconds

The heads are picked based on the potential score such as the energy and the mobility as shown in figure 3. The readers which have high energy and similar mobility are selected as a cluster heads in the network.

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Figure 3: Cluster Head Selection.

Once the cluster heads are selected, the remaining readers and tags will join the cluster based on the mobility as shown in figure 4. The distance between the members of nodes is maintained to avoid collision. The members of nodes move towards cluster head for improving the data transmission inside the cluster in the network.

Figure 4: Cluster Formation in the network.

In Figure 5 we learn the total number of selection of cluster head rounds by the active nodes in the RFID network. This graph is drawn using dragonfly and LEACH protocol. In the graph, x axis is taken as total number of alive nodes and y axis is taken as number of rounds for election of cluster head. This graph helps in evaluating the overall cost of applying DCP to the optimal cluster head election method. From the selection rounds (over 600 rounds) optimal cluster heads are selected using proposed technique which prevents frequent cluster breakage. On the other side, LEACH decreases at a faster rate due to the inefficient clustering methodologies for head node selection used in the network.

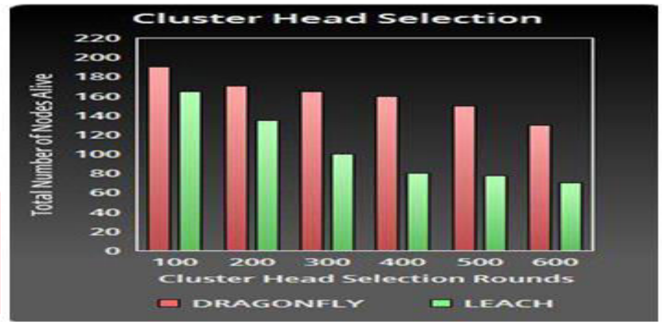

Figure 5: Number of Dragonfly-based Cluster Head Selection.

With variation of number of nodes the residual energy is maintained in the Dragon fly algorithm when compared to LEACH scheme as shown in figure 6.

Figure 6: Residual energy comparison of dragonfly and LEACH.

7. CONCLUSION

To improve the performance of the network several energy based clustering techniques are designed. The issue of picking the optimal cluster head is often known as an optimization problem. In this paper, Dragonfly clustering protocol (DCP) is applied for optimally choosing the cluster head. The proposed DCP protocol reduces the cluster breakage by selecting the cluster head with high residual energy level and similar mobility. The energy consumption is reduced by avoiding cluster breakage. In this clustering strategy, redundant data are eliminated by aggregating the data at the head. It improves the reading efficiency as compared to certain existing techniques in RFID network. The simulation results states that DCP provides better performance in terms of lifetime, energy consumption and average number of packets communicated to the base station.

REFERENCES

[1] V. Kumar, S. Jain and S. Tiwari, “Energy Efficient Clustering Algorithms in Wireless Sensor Networks: A Survey”, Journal of Computer Science Issues, vol. 8, no. 2,

ISSN 2395-695X (Print)
ISSN 2395-695X (Online)
International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)
Vol. 2, Special Issue 14, May 2016

(2011), pp. 259-268.

[2] M. Thangaraj and P. P. Ponmalar, "A Survey on data aggregation techniques in wireless sensor networks", Journal of Research and Reviews in Wireless Sensor Networks, vol. 1, no. 3, **(2011)**, pp. 36-42.

[3] S. Ali and S, Madani, "Distributed Efficient Multi Hop Clustering Protocol for Mobile Sensor Networks", International Arab Journal of Information Technology, vol. 8, no. 3, **(2011),** pp. 302- 309.

[4] G. S. Kumar, M. V. V. Paul, K. P. Jacob, "Mobility metric based leach-mobile protocol", Proceedings on the 16th International Conference on Advanced Computing and Communications, **(2008)** , pp. 248-253.

[5] D. S. Kim and Y. J. Chung, "Self-Organization Routing Protocol Supporting Mobile Nodes for Wireless Sensor Network", Proceedings on the 1st International Multi-Symposiums on Computer and Computational Sciences, **(2006)**, pp. 622-626.

[6] Vivek Chandran. K and Nikesh, "Elimination of Data Redundancy and Latency Improving in Wireless Sensor Networks", International Journal of Engineering Research & Technology (IJERT), Vol. 3, pp. 8, August 2014.

[7] W. R. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy Efficient Communication Protocol for Wireless Microsensor Networks", Proceedings of the 3rd Annual Hawaii International Conference on System Sciences, **(2000)**, pp. 3005-3014.

[8] Victoria Bueno, Pablo Pavon Marino And Maurizio Rebaudengo, "A Geometric Distribution Reader Anti-Collision Protocol For RFID Dense Reader Environments", IEEE Transactions On Automation Science And Engineering, Vol. 10, No. 2, pp. 636-652, April 2013.

[9] Hiren Thakkar, Sushruta Mishra and Alok Chakrabarty, "A Power Efficient Cluster-Based Data Aggregation Protocol For WSN (MHML)", International Journal of Engineering and Innovative Technology (IJEIT), Vol.1, pp. 4- 16, April 2012.

[10] Younis O, Fahmy S, " HEED: a hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks" , IEEE Trans on Mobile Computing, 2004, 3(4), p. 366-379.

[11] Bala Krishna and Noble Vashishta, "Energy Efficient Data Aggregation Techniques in Wireless Sensor Networks ", 5th International Conference on Computational Intelligence and Communication Networks, 2013.

[12] Fall K, Varadhan K (2009) The NS manual. The VINT Project, Berkley, USA.

ISSN 2395-695X (Print)
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International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)
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