IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

# AN ENERGY EFFICIENT BASED ALGORITHM OF DATA COLLECTION IN WIRELESS SENSOR NETWORK

Ge Bin[1], Christian M. Gilles[2*]

[1]Department of computer science and engineering, Anhui University of Science and Technology, Huainan, Anhui Province, 232001, China.
[2]Department of computer science and engineering, Anhui University of Science and Technology, Huainan, Anhui Province, 232001, China.
[*]mchrisgilles@gmail.com

**ABSTRACT**

Wireless Sensor Network consists of a group of sensor nodes with a sink node as a gateway display all over an area of interest to collect information. Each node of the network is responsible for sensing and collect certain physical properties then send them to a gateway and delivered to a computer. In the present study, the information is aggregated to the gateway in a Multi-hop system to manage the energy consumption of the mobile sink node. Taking into account the mobile sink node frequent location change, the energy-harvesting model will enhance its performance to avoid data loss and network delay. In this paper, we proposed a pathfinding algorithm for sink nodes to improve the quality of data and network lifetime. Further, the proposed system is implemented to show the effectiveness in operation by network simulation, in addition to the theoretical analysis.

***Keywords:*** Multi-hop; Data collection; Network Delay; Energy harvesting.

## 1. INTRODUCTION

In the last decade, technological developments in the internet of things with wireless sensor networks (WSN) devices are making life safer and easier for millions of people. These systems use sensors to function together at various points, such as temperature, sound, vibration, physical and environmental conditions, pressure, activity, or toxins etc... In various civil applications, today's wireless sensor network is being used, such as environmental and tracking logistics [1–3], wellbeing monitoring, smart city [4], and traffic control [5].

The cost savings of sensors and network designs have increased wireless sensor network growth. Sensor nodes provide several features of advanced technologies, such as low expense, low power usage, smaller measurements, multifunction and short-range communication. The sensor's processing ability is reduced compare to the personal computer. The sensor node size also reduces the battery power [6].

The architecture protocol in WSNs therefore usually relies on the simplicity and power-saving concept. A wide number of sensors are typically used at random and not one by one in the environment. The plunge's calculation ability is larger than the normal nodes. The sensor data is processed on the network for decision-making purposes. As the transmission is small, it cannot be moved in one hop directly to the drain. In multi-hop methods, other sensors are often required to transmit data. The sensor, normally closest to the plumbing, uses more power to transmit data than the sensor further from the plumbing grid.

To solve this dilemma, there have been various researchers in the network setting on how the dish transfers and receives info. These strategies are planned to avoid multi-hop extra energy usage [7]. Through going to visit any of the sensor nodes, the mobile sink will reduce the volume of data transmitted. Since the mobile sink exploits its versatility to save multi-hop power usage, sensor nodes must use power to sensors and relay. The sensor node has to relay data as far as possible without several hops to solve this issue.

Rather, the sensor nodes have to wait before the mobile sink arrives and pass the sensing data directly to the sink. The mobile sink is going at a small pace. The longer the gap, the longer it takes to travel. The preparation of the mobile sink would not only affect the pause in data transmission, it will also affects the energy use.

Therefore, the proposal for the data recovery route of the mobile sink is a daunting research problem. Certain studies capture the data using a smart computer. These approaches are therefore structured to lower environmental energy usage without recognizing knowledge content (QoI) [8]. The majority of the document shall be sorted accordingly. The remainder of the paper is sorted out as follows. Area II presents a short survey of energy-efficient algorithms strategies in WSN. Part III Segment discussed Energy Harvesting Path Finding Strategy. Part IV discussed Simulation results and eventually, Part V concludes the paper.

## 2. RELATED WORKS

A number of studies on low power algorithms propose mobile charging of the sensor node due to its efficiency as an optimization method [9–14]. This method also adopt taking energy from friendly energy sources it's surrounding. In [15] the literature proposed a clustered energy efficient routing algorithm for a path optimization strategy to charge the sensor nodes. His method construct a routing tree with minimum energy-load consumption in each data collection round and determine the routing strategy of the sensor nodes in each station to obtain better optimization results.

In [16] the paper proposed two wireless chargers(fixed and mobile) for sensor nodes where the mobile one move to the location of sensor nodes and the fixed one invites the mobile sensor nodes at the base station for charging. This method extended the network lifetime and simulation show that this algorithm deliver improvement in node failure rate compare to other algorithms. The proposed method in [17] introduce a periodic charging time scheduling algorithm for path planning with multiple chargers. This method gained considerable time by carrying multiple portable chargers when charging the sensors. In [18] a protocol of energy aware multi-hop routing was presented that consists of 2 main phases a setup phase where cluster heads are elected in cluster members to help in transmission of data and steady phase when data is collected from the elected cluster head and new cluster head elected to avoid energy depletion in the system.

The authors in [19] developed a greedy scanning data collection strategy to reduce routing energy depletion. This study propose that the mobile sink search for the shortest path to the area with more sensory data and make the decision according to the change in the network to save energy. We will classify algorithms of data collection with a mobile sink as follow in figure 1.

[1] Uploading pattern.

[2] Organization pattern of network structure.

[3] Moving pattern of mobile sink.

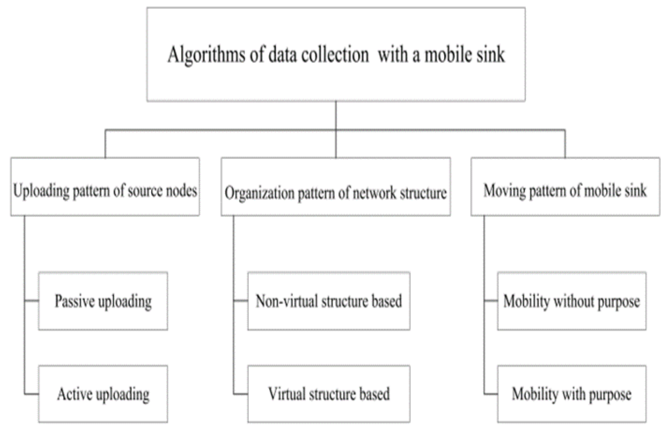


**Figure 1.** Categories of data collection algorithms with mobile sink

Numerous applications use WSNs. Different applications need multiple data forms. The mobile sink is used by current strategies to collect data from sensors to solve the limited maximum latency. Sensors are clustered at a certain distance in [24] and one sensor from the community is chosen as the storage point for storing data. It is necessary to increase the consistency of knowledge because any information needs to be discarded. This technique, however, has fixed storage points for data. Although the power usage of the chosen data storage points is greater than that of the other sensors, the sensors will die prematurely since the storage point is a storage point.

In [21], they suggested a procedure for coping with the various specifications of the application. To increase the efficiency of data collection dynamically, the sensor nodes may change their transmitting range. The sink will track the state of data collection according to the specifications of the request. To adjust the transmission time, the sink often sends a warning message to the sensor at regular intervals, attempting to improve network output. The sensor can automatically change its sleep-wake schedule to reach the delay limit of each program after obtaining the warning. This procedure, though, is sufficient for the conventional fixed sink rather than the handheld sink. Any other approaches assume that the sensor will store its data in its storage and is waiting for the location of the mobile sink [20, 25].

The mobile sink data selection linear programming module is suggested to expand the lifespan of the network [22]. The mobile sinks travel period in this module covers both transmitting and receiving. The mobile sink's power is converted to the full walkable duration and the sensor storage capacity will schedule the direction of the data array. The mobile sink power considerations influence include the mobile sink power, the maximum distance between the two target points, and the minimum dwelling period in each stop location.

This approach, however, maximizes the running time of the network, instead of QoI. Since the delay of movement of the mobile sink has been taken into account in data transmission, it aims to prevent data overflow with reduced buffer space. The mobile sink measures the net benefit of each position as the parameter for a goal point to be chosen. The energy usage of the mobile sink would decrease if the mobile sink merely selects the target quantity of data. The visiting order of the targets is significant, particularly if the mobile sink's power is reduced. Dependent on the weight value, many approaches evaluate the goal points. The weight values of the methods designed are different, but they are typically calculated by many parameters, including the remaining strength of the sensor node, the rate of data production, the storage capacity, and the number of sensors within the range of communication [23].

**3. Energy Harvesting Path Finding Algorithm**

Belongs to the proposed technique based on Figure 2. The two central points of the given model represent charging points. The sink node begins from the charging point (center C1), makes a trip as indicated by the pre-arranged information assortment way, and afterward re-visitations of another charging station (center f2). The energy of the sink node is used to determine the size of the ellipse. The furthest distance is from the center f1 to the limit of the model and then return to the central point C2. The P is the origin for all points on the model shown as in Figure 2.

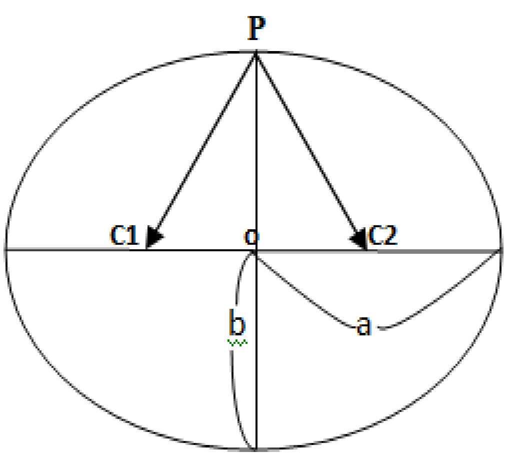


**Figure 2**. Ellipse model.

Figure 2. Model details are present in equation (1), where the $x_o$, $y_o$ are axis coordinates and a, b are semi-major and minor points of axis, respectively.

$$\frac{(x-x_o)^2}{a^2}+\frac{(y-y_o)^2}{b^2}=1 \qquad (1)$$

In the elliptical formation, the transmitted data collection into multiple regions is given in Fig.3.

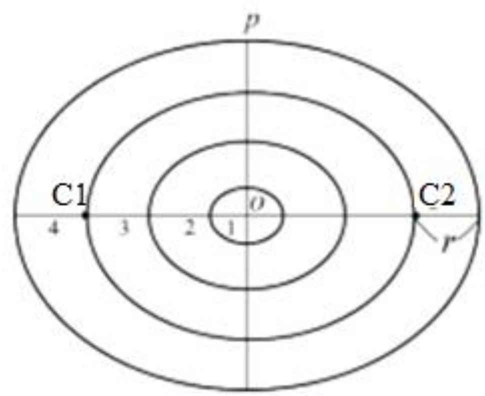


**Figure 3.** Region Model.

$$w_i = \alpha \times CU_i + (1-\alpha)\times\frac{Ny_n}{NY} \qquad (2)$$

The sink node collects data from the sensor node and starts from the charging station that is in the network. Sink node visits the targeted node is select based on wi. The area of node I located as to present in equation (2), where $Ny_n$ is the number of layers in the network, $Ny_n$ is the nth layer of the ellipse, and α is a capacity usage CUi of the sensor i. The capacity is nothing but allocated data rate improving along with time.

An illustration of pathfinding for the sink is given in fig.4. In the initial step, the sink node charging point starts from C1, after that the sensor node n selected along with wi as given in Fig. 4(a). In the case of a sensor, A has the highest wi. In the next step, the sink node is selected sensor node Q visited next sensor node and at the end visits the charging point C2. At the present, we consider C1 and Q as two points of ellipse and energy from another new ellipse E1. In addition, we took Q and C2 as two points of ellipse-consuming energy from another new ellipse E2 as shown in Fig. 4(b). Assume the sensor C has maximum wj. After that, another travel path, C1, Q, R, and C2 is designed as shown in Fig. 4(c). As per the last step, we can identify the new visited sensor S. At last, the mobile sink plans a travel path from C1, Q, R, S, and C2 as shown in Fig. 4(d).

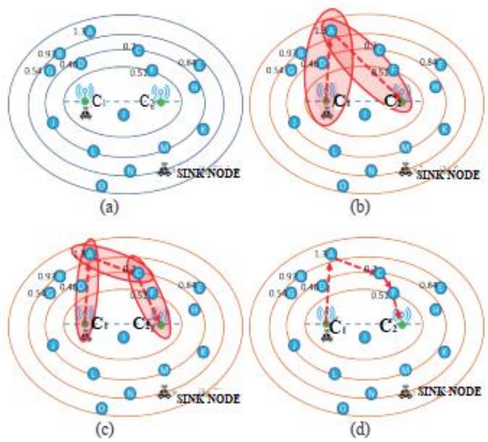


**Figure 4.** Example of a travel schedule of the sink node

Sink node data sending path used to gather the data and visit for each cycle. However, few sensor nodes are may not locate at data travel path. While the sensor nodes address the delay or capacity use requirements, the data will be sharing in multi broadcast to sink node. Every node i trace the two recent located timestamps (tsi1, tsi2). The predefined fixed time based timestamps of the sensor will be refreshed to (tsi1,∞) if the mobile sink does not locate the nodes frequently.

$$CN_i = 1/(ts_i^1 - ts_i^2) \quad (3)$$

The sink node builds communication path and place changing to locate the nodes and used to collect the data. The sink cannot collect the data when the node capacity drained or delay requirement. So, always sensor nodes try to find neighbor node to transmit data to the sink node. As given in Fig. 4, imagine that capacity of node T is completely used or delay requirement will address the node T chooses most extreme CNi dependent on equation (3) to discover retransmit neighboring node D. This node gets information to achieve a comparable strategy and discover retransmit node Q. In the end, data transmitted to the sink node. The transmitted data communicated to the sink node finally.

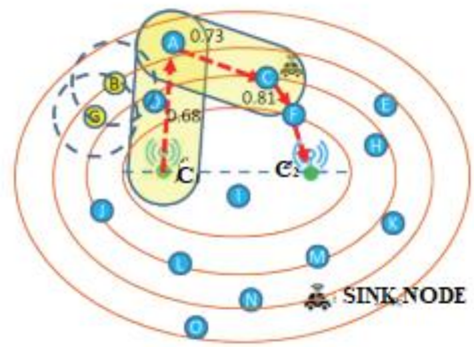


**Figure 5**. Data transmission to the sink node

## 4. Result of Proposed System

In this part, we evaluate our proposed algorithm EHPF. For these results, 30 sensors we used randomly in the network area. The sensor's broadcast range is 30 mm. The residual sensor energy is 100J. It begins from one charging station to another for the sink to reload.

### *A.* Network Delay

The result of network delay evaluates network delay and lifetim e by adjusting the requirement for the delay. Just in figure 6, we can observe the delay in the network. The proposed algorithm enhances the information quality.

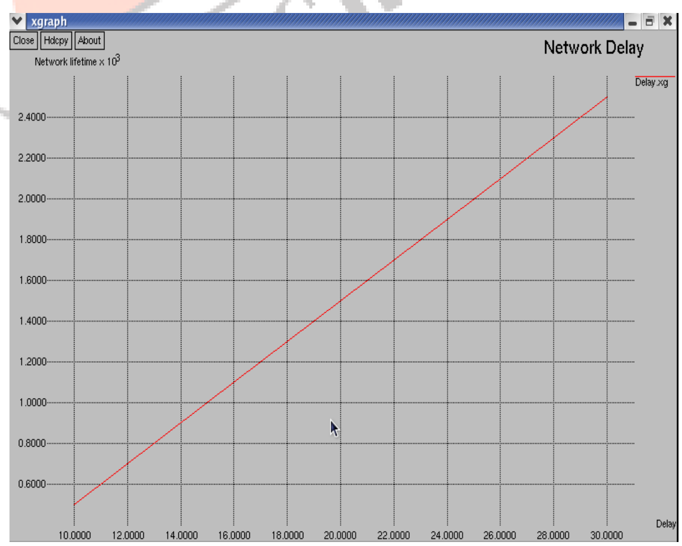


**Figure 6**. Network delay.

### *B.* Performance of Transmission Capacity

The transmission capacity result measures the observed network lifetime by adjusting the sensor transmission capacity. The num ber of sensors located in the transmission also increases when th e capacity rises. When the transmission range high, the number of hops of multi-hop is less.

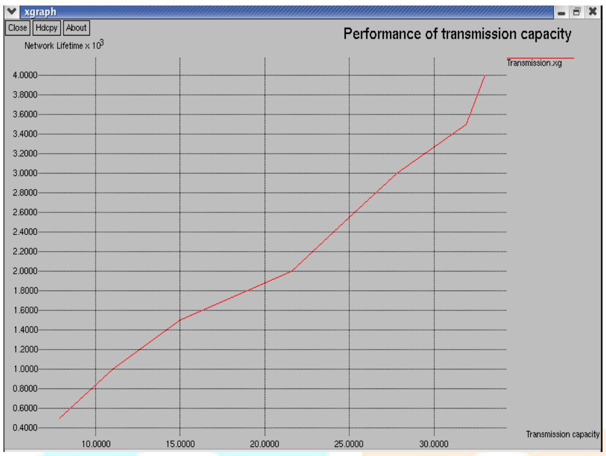


**Figure 7**. Performance of transmission capacity.

### *C.* The System Throughput

Throughput result evaluates network lifetime by varying the throughput. The travel path of length also increases when the throughput increases.

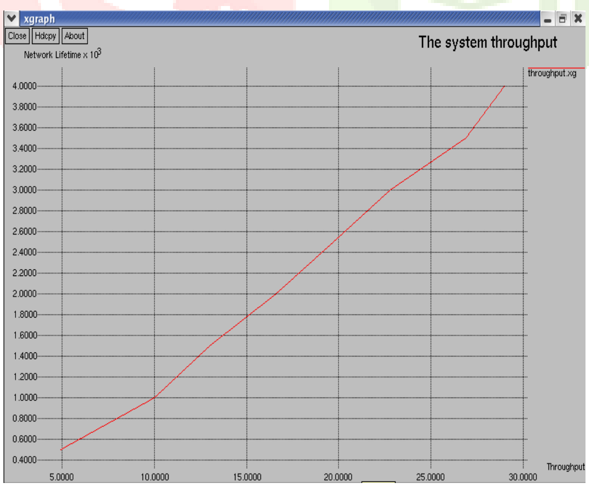


**Figure 8**. The system throughput.

## 5. CONCLUSION

In WSN, the sink node is used to effectively collect data from sensor nodes by power losses and increase the lifetime of the network. This system proposes a strategy for pathfinding includes the quality of information. The sink node establishes the travel path based on the proposed model under the energy limit, it visits the sensors as soon as possible. When the sensors appear delayed, by selecting the appropriate neighboring sensor, they can aim to transmit data to the sink node in a Multi-communication system. The result of the proposed framework would improve the information quality and network lifetime.

## REFERENCES

1. D, M.M.: Energy Efficient Techniques Object Tracking in Wireless Sensor Network. pp. 2732–2738, 2016.
2. Xing, J.: An intelligent logistics tracking system based on wireless sensor network. Int. J. Online Eng. 14, pp. 17–28, 2018.
3. Wen, Y., Gao, R., Zhao, H.: Energy efficient moving target tracking in wireless sensor networks. Sensors (Switzerland). pp.16, 1–11, 2016.
4. Republic of Rwanda: Smart city Rwanda MasterPlan. version 2., pp. 1–84, 2019.
5. Huang, Y., Wang, L., Hou, Y., Zhang, W., Zhang, Y.: A prototype IOT based wireless sensor network for traffic information monitoring. Int. J. Pavement Res. Technol. 11, pp. 146–152, 2018.
6. Geng, H.: Internet of things and data analytics handbook. CITS Group, San Jose, CA, USA (2017).
7. Dhand, G., Tyagi, S.S.: Data Aggregation Techniques in WSN:Survey. In: Procedia Computer Science. pp. 378–384, 2016.
8. Liu, X., Liu, W., Liu, Y., Song, H., Liu, A., Liu, X.: A trust and priority based code updated approach to guarantee security for vehicles network. IEEE Access. 6, pp. 55780–55796, 2018.
9. Sangare, F., Xiao, Y., Niyato, D., Han, Z.: Mobile Charging in Wireless-Powered Sensor Networks: Optimal Scheduling and Experimental Implementation. IEEE Trans. Veh. Technol. 66, pp.7400–7410, 2017.
10. Fu, L., He, L., Cheng, P., Gu, Y., Pan, J., Chen, J.: ESync: Energy synchronized mobile charging in rechargeable wireless sensor networks. In: IEEE Transactions on Vehicular Technology. pp. 7415–7431, 2016.
11. Luo, W., Shi, S., Lu, Y., Zou, S., Chen, Z., Chen, L.: Optimization Study of Outburst Prevention Measures for Tuzhu Coal Mine Based on Fixed Weight Clustering Analysis. J. Geosci. Environ. Prot. 04, pp.153–161, 2016.
12. Han, G., Guan, H., Wu, J., Chan, S., Shu, L., Zhang, W.: An Uneven Cluster-Based Mobile Charging Algorithm for Wireless Rechargeable Sensor Networks.

IEEE Syst. J. 13, pp. 3747–3758, 2019.

13. Wang, C., Li, J., Yang, Y., Ye, F.: Combining Solar Energy Harvesting with Wireless Charging for Hybrid Wireless Sensor Networks. IEEE Trans. Mob. Comput. 17, pp. 560–576, 2018.

14. Liao, W.H., Kuai, S.C., Chang, C.K.: Energy Harvesting Path Planning Strategy on the Quality of Information for Wireless Sensor Networks. In: Proceedings of 2019 IEEE International Conference of Intelligent Applied Systems on Engineering, ICIASE 2019. pp. 82–85, 2019.

15. Zhang, S.: Path optimization strategy for charging nodes in wireless sensor networks. 6, pp. 129–135, 2019.

16. Soni, S., Shrivastava, M.: Novel wireless charging algorithms to charge mobile wireless sensor network by using reinforcement learning. SN Appl. Sci. 1.9, pp. 1-18, 2019.

17. Hu, M., Chen, Z., Peng, K., Ma, X., Zhou, P., Liu, J.: Periodic Charging for Wireless Sensor Networks With Multiple Portable Chargers. IEEE Access. 7, pp. 2612–2623, 2019.

18. Cengiz, K., Dag, T.: Energy Aware Multi-Hop Routing Protocol for WSNs. IEEE Access. 6, pp. 2622–2633, 2017.

19. Zhu, C., Zhang, S., Han, G., Jiang, J., Rodrigues, J.J.P.C.: A greedy scanning data collection strategy for large-scale wireless sensor networks with a mobile sink. Sensors (Switzerland). 16, pp. 109–309, 2016.

20. N. Ayoub, M. Asad, M. Aslam, Z. Gao, E. U. Munir, and R. Tobji, "MAHEE: Multi-hop Advance Heterogeneity-aware Energy Efficient Path Planning Algorithm for Wireless Sensor Networks," IEEE Pacific Rim Conference on Communications, Computers and Signal Processing (PACRIM), 2017- Proceedings. pp.1-6, 2017.

21. H.-L. Fu, P. Lin, Y. Fang, and T.-Y. Wang, "Trade-off between Energy Efficiency and Report Validity for Mobile Sensor Networks," ACM Transactions on Sensor Networks (TOSN), Vol. 9.4, No. 4, pp. 1-19, 2013.

22. W. Liang, J. Luo, and X. Xu, "Prolonging Network Lifetime via A Controlled Mobile sink in Wireless Sensor Networks," IEEE Global Telecommunications Conference (Globecom), pp. 1-6, 2010.

23. Li, Ke, Chien-Chung Shen, and Guaning Chen. "Energy-constrained bi-objective data muling in underwater wireless sensor networks." *The 7th IEEE International Conference on Mobile Ad-hoc and Sensor Systems (IEEE MASS 2010)*. IEEE, pp. 332-341, 2010.

24. Y.-C. Tseng, W.-T. Lai, and C.-F. Huang, "Using Mobile Mules for Collecting Data from An Isolated Wireless Sensor Network," IEEE 39th International Conference on Parallel Processing (ICPP), pp. 673-679, 2010.

25. W. Wen, Z. Dong, G. Chen, S. Zhao and C.-Y. Chang "Energy Efficient Data Collection Scheme in Mobile Wireless Sensor Networks," IEEE International Conference on Advanced Information Networking and Applications Workshops (WAINA), IEEE, pp. 226-230, 2017.

26. Han, G., Guan, H., Wu, J., Chan, S., Shu, L., Zhang, W.: An Uneven Cluster-Based Mobile Charging Algorithm for Wireless Rechargeable Sensor Networks. IEEE Syst. J. 13, pp. 3747–3758, 2019.

## AUTHOR PROFILE

**CHRISTIAN GILLES MUNYAKAYANZA** Currently M.tech student from Department of computer science, Anhui University of Science and Technology (AUST). His Research interest includes Wireless Sensor Networks.

## AUTHOR PROFILE

**Bin Ge** Ph.D. in computer application from Hefei University of technology. He teach at Anhui University of Science and Technology (AUST). His Research interest includes information security, internet of things technology and artificial intelligence.