

# ANALYSIS OF THE INFLUENCE OF BIOCHEMICAL INDEXES OF ATHLETES UNDER TRAINING BASED ON THE INTERNET OF THINGS AND CLOUD COMPUTING



ORIGINAL ARTICLE  
ARTIGO ORIGINAL  
ARTÍCULO ORIGINAL

ANÁLISE DA INFLUÊNCIA DOS ÍNDICES BIOQUÍMICOS DOS ATLETAS EM TREINAMENTO COM BASE NA INTERNET DAS COISAS E NA COMPUTAÇÃO EM NUVEM

ANÁLISIS DE LA INFLUENCIA DE LOS ÍNDICES BIOQUÍMICOS DE LOS ATLETAS EN EL PERÍODO DE ENTRENAMIENTO BASADO EN INTERNET DE LAS COSAS Y LA COMPUTACIÓN EN NUBE

Weidong Yang<sup>1</sup>   
(Public Health Education)  
Huan Huang<sup>1</sup>   
(Public Health)

1. Sports Education Centre, Xijing University, Xi'an, 710123, Shaanxi, China.

## Correspondence:

Xi'an, 710123, Shaanxi, China.  
zu940fsyg146@126.com.

## ABSTRACT

For athletes under training, it is more efficient to use the Internet of Things (IoT) and cloud computing methods to collect and process biochemical indicators, and this study is about research based on the IoT and cloud computing technology for athletes under training. The problems are put forward in this study. The requirements of related algorithm design and the communication model properties are comprehensively analyzed. Scheduling the link and allocating the transmit power of the nodes are comprehensively considered, with design and analysis of wireless sensor network scheduling algorithm. The factors influencing the scheduling efficiency of the algorithm are analyzed, considering the node density and the influence of different power allocation schemes on the scheduling result. This study shows that the algorithm of this thesis can collect the biochemical index data of athletes during training period. As the number of nodes increases, the running results will gradually move towards the optimal value. This research study is of important theoretical significance for the application of IoT and cloud computing technology and the improvement of athlete training effect.

**Keywords:** Internet of Things; Cloud Computing; Exercise; Biochemical Phenomena.

## .RESUMO

Para os indicadores bioquímicos dos atletas durante o treino, é mais eficiente usar a internet das coisas e métodos de computação em nuvem para coletar e processar indicadores bioquímicos durante o treino de atletas. Este estudo se baseia na tecnologia da internet das coisas IoT e na computação em nuvem voltada para atletas durante o período de treino. Os problemas são apresentados neste documento. Os requisitos de concepção de algoritmos relacionados e propriedades do modelo de comunicação são amplamente analisados. A programação do link e a alocação da potência de transmissão dos nodos são considerados de forma abrangente, com projeto e análise do algoritmo de programação da rede de sensores sem fio. Os fatores que influenciam a eficiência de programação do algoritmo são analisados, considerando a densidade do nodo e a influência de diferentes sistemas de alocação de energia no resultado da programação. A pesquisa mostra que o algoritmo desta tese pode coletar os dados do índice bioquímico dos atletas durante o período de treino. À medida que o número de nodos aumenta, os resultados de execução tenderão gradualmente para o valor ideal. Esta pesquisa tem um significado teórico importante para a aplicação da tecnologia da internet das coisas e computação em nuvem e para a melhoria do efeito dos treinos realizados por atletas.

**Descritores:** Internet das Coisas; Computação em Nuvem; Exercício; Fenômenos Bioquímicos.

## RESUMEN

Para los indicadores bioquímicos de los atletas durante el entrenamiento, es más eficiente usar la internet de las cosas y métodos de computación en nube para recolectar y procesar indicadores bioquímicos durante el entrenamiento de atletas. Este estudio se basa en la tecnología de la internet de las cosas IoT y en la computación en nube dedicada a atletas durante el período de entrenamiento. Los problemas son presentados en este documento. Los requisitos de concepción de algoritmos relacionados y propiedades del modelo de comunicación son ampliamente analizados. La programación del link y la destinación de la potencia de transmisión de los nodos son considerados de forma abarcadora, con proyecto y análisis del algoritmo de programación de la red de sensores inalámbrica. Los factores que influyen la eficiencia de programación del algoritmo son analizados, considerando la densidad del nodo y la influencia de diferentes sistemas de destinación de energía en el resultado de la programación. La investigación muestra que el algoritmo de esta tesis puede recolectar los datos del índice bioquímico de los atletas durante el período de entrenamiento. A medida que el número de nodos aumenta, los resultados de ejecución tenderán gradualmente hacia el valor ideal. Esta investigación tiene un significado teórico importante para la aplicación de la tecnología de la internet de las cosas y computación en nube y para la mejora del efecto de los entrenamientos realizados por atletas.

**Descriptor:** Internet de las Cosas; Computación en Nube; Ejercicio; Fenómenos Bioquímicos



## INTRODUCTION

With the continuous development of the application of IoT, the collection and processing of biochemical indicator data during the training period of athletes has become easier. In the past few years. More and more attention has been paid to the research on how to use the existing wireless communication technology to transmit the biochemical index data of athletes during training period sensed by sensors to the data center of backstage athletes' biochemical index during training period through self-organizing network as far as possible.<sup>1</sup> For athletes' biochemical indicator data during training period, the changes are frequent and the collection efficiency is low. If the IoT and cloud computing technology can be used to process, the work efficiency can be greatly improved. Most IoT applications require full awareness of the target, that is to say, the sensor node needs to collect and transmit a large number of athletes' biochemical indicator data during the training period, and the application has higher real-time requirements for the athletes' biochemical indicator data during training period.<sup>2</sup> Based on this, the biochemical indicators of athletes during training period based on IoT and cloud computing technology is studied.

As for the research method, the SINR (signal-to-interference-plus-noise ratio) model and the existing wireless sensor network scheduling method are analyzed. Combining the characteristics of nodes in wireless sensor networks and the full-space interference characteristics of SINR model, the distributed design of the target algorithm is carried out so that the algorithm has lower computational complexity and can meet the needs of practical applications.<sup>3</sup>

The research in this research is of certain innovation. By analyzing the related properties of the interference model, the problem of maximizing the network capacity of the wireless sensor network is transformed into an approximate equivalence problem, which is used as each sensor in the wireless sensor network. The node discriminates whether it communicates based on local information collected by itself or not. At the same time, by introducing the ideal interference model hypothesis and using its properties, a new distributed network scheduling scheme is obtained.

This research is divided into three parts. The first part is the literature review. The second part is the data processing algorithm analysis of the biochemical indicators of athletes during the training period of the IoT and cloud computing, including the method analysis of data processing of athletes' biochemical indicators during training period under the IoT and cloud computing, and the demand analysis of scheduling algorithm design, etc. The third part verifies the algorithm proposed in this paper.

## RELATED WORK

According to Narman HS, Wireless Sensor Networks (WSNs) are multi-hop ad hoc networks formed by a large number of sensor nodes deployed in the monitoring area, which are the basic network communication technology for IoT applications.<sup>4</sup> Linthicum DS proposed that WSNs is a non-central wireless ad hoc network with the advantages of rapid deployment, high fault tolerance and strong concealment, so it can be widely used in smart logistics, environmental monitoring, smart home, military defense, intelligent transportation, human health testing and many other fields.<sup>5</sup> Ray PP propose that with the maturity of related technologies such as wireless communication, sensor technology, and embedded applications, WSNs can obtain the biochemical indicator data of athletes' physiological athletes during training at any time, place, and environmental conditions, laying the technical foundation for the development of the IoT (IoT).<sup>6</sup> Sahni Y proposed that many scholars have conducted research on practical applications in this area. In WSNs, two nodes rely on a wireless channel for communication. In a general environment, wireless communication is usually interfered with by such

things as ambient noise and other nodes transmitting signals. Ma Y put forward that for any pair of sending and receiving nodes in the network, only when the receiving node receives the power of the wireless signal sent by the sending node greater than a certain threshold, can the receiving node accurately identify the biochemical index data information sent by the sending node during the training period of athletes' physiological athletes. Srirama SN believes that when the receiving node can successfully receive the biochemical indicator data of the athlete's physiological athlete training period sent by the sending node, it defines a wireless link between the two nodes. Kumrai T hold the view that for a wireless sensor network, the network capacity in a particular area is defined as the number of links in that area, i.e. the number of pairs of nodes that can communicate. Wei Z proposed that in most cases, the wireless communication environment is more complex than the wired communication environment. The quality of the wireless link between nodes is affected by noise and other nodes, such as distance attenuation and multipath propagation, signal reflection, refraction, and Doppler effect, etc. El-Sayed H thinks that, in general, when the interference received by the receiving node increases, the transmitting node must increase its transmit power to ensure that the receiving node can establish a wireless communication link with the transmitting node

## EXPERIMENTAL DESIGN AND ANALYSIS

### Experimental environment

The attenuation index  $\alpha$  of the signal varies according to the environment, and the value areas are mostly distributed between 2 and 4 in different environments. When it is in the indoor environment, its value is mostly distributed between 4 and 6. Considering the actual application environment in the warehouse, set  $\alpha=5$  as the wireless signal attenuation index. In the meantime, it is assumed that  $\beta=1.2$ . Since the warehouse belongs to the indoor environment, the ambient noise is relatively small compared to the outdoor, so the environmental noise is assumed to be  $N=1$ . For the following experiments, the preliminary preparations for the experiments in MATLAB are as follows: Through the hypothesis of the experimental plane, that is to say, the length of the plane is assumed first, the experimental space is constructed, and the nodes are randomly and evenly distributed in the plane. By using the location of nodes and the maximum communication range of each node, the set of communication links is generated, and the corresponding adjacency matrix is calculated. For the sake of generality, it is assumed that each node is evenly distributed in the warehouse or space, that is to say, the uniform distribution generator `unifrnd(a, b)` in MATLAB is used, in which a, b are used to represent the uniformly distributed range, and a random number conforming to a uniform distribution is generated. In the following experiments, only the experimental basis established above is needed, and the corresponding parameters are determined for different experimental requirements. The MATLAB code is listed in the appendix, among which the code is divided into two parts, namely the scheduling algorithm and other related algorithm.

### Analysis of experimental results

In order to test the performance and reliability of the algorithm, the algorithm is mainly simulated and analyzed in this part and the performance of the algorithm in the case of different node densities is firstly considered. It is assumed that 20 sensor nodes are randomly distributed in a plane of  $10 \times 10$  m<sup>2</sup> and  $P_{max} = 40$ . Therefore, by running the scheduling algorithm, the following results can be obtained, as shown in Figure 1.

Each node in the graph represents a sensor node, and each edge represents the communication link finally filtered by the scheduling algorithm.

Figure 2 is only used to represent the topology between nodes, but does not contain location information. In order to get the influence of different node densities on the performance of the algorithm, the application environment with higher node densities is simulated below. Assuming that there are 20 nodes scattered randomly in a plane of  $5 \times 5 \text{ m}^2$ , the above experiments are repeated and the results are shown in Figure 2.

According to the above analysis, the following preliminary judgment is obtained that when the node density is large, the operation efficiency of the scheduling algorithm becomes lower, and in other words, by comparing between Figure 2 and Figure 3, it is observed that there is a significant difference in the scheduling result. In order to further analyze the influence of node density on the scheduling algorithm, it is considered that 100 nodes are randomly and uniformly dispersed in a plane of size  $100 \times 100 \text{ m}^2$ . The attenuation index is the same as the above experiment, and  $P_{\text{max}}=100$ . At the same time, the node density is controlled by gradually reducing the size of the distribution plane. The experimental results are shown in Figure 3.

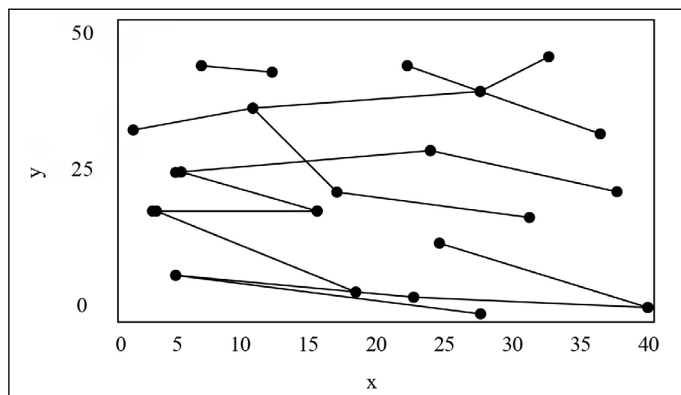


Figure 1. Low Node Density Scheduling Results.

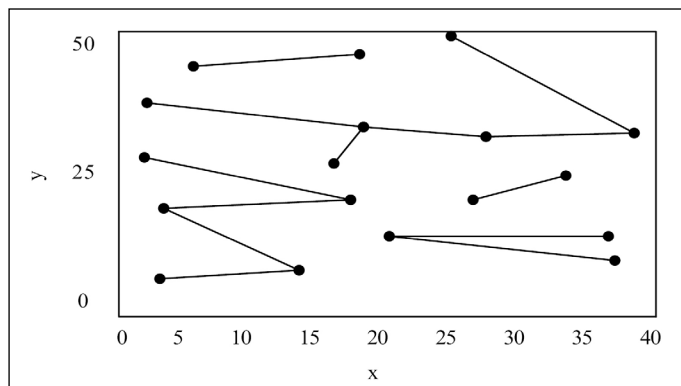


Figure 2. High Node Density Scheduling Results.

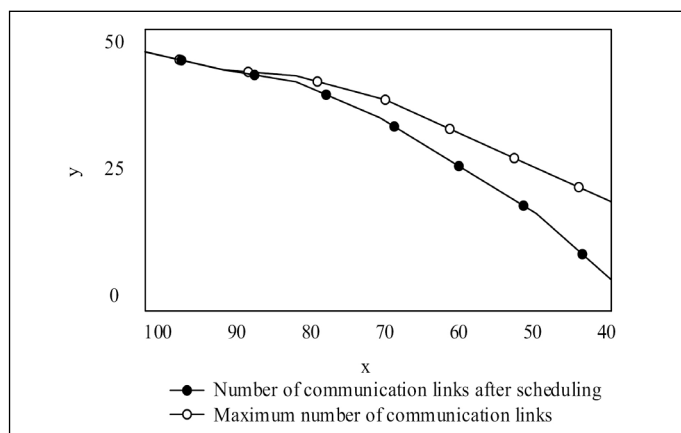


Figure 3. Node Density and Scheduling Results.

It can be seen from the above simulation results that the result of scheduling by the scheduling algorithm of this paper is affected by the node density compared with the "maximum number of communication links" calculated by the known global information. When the node density is larger, the operation effect is obtained. The impact will also be greater. The main reason for the analysis is that it uses an iterative approach when assigning energy to nodes. As a result, when the node density is large, continuous iteration tends to amplify interference between nodes, thereby reducing the number of pairs of communicable nodes. Secondly, by observing the above scheduling algorithm, the coefficient  $\theta$  plays a more important role in the process of determining the node assignment and whether the pair is communicating. Therefore, examine the relationship between the selection of coefficient  $\theta$  and the efficiency of the scheduling algorithm is examined in this study. The simulation background is the same as the previous experiment, which assumes that there are 100 nodes in the plane of  $100 \times 100 \text{ m}^2$ , and the experimental results are shown in Fig. 5. The X-axis in Fig. 5 shows the initial  $\theta$  value of each node is 1-7, and the Y-axis shows the number of nodes that can communicate in parallel. By choosing different initial values of  $\theta$ , the initial transmission power of each node increases continuously, which will inevitably lead to the increase of mutual interference between nodes, and affect the scheduling efficiency of the above-mentioned distributed algorithm. Fig. 4 shows that when the initial transmission power allocated by each node increases, the interference between links in the whole network will be directly increased. When the value increases to a certain extent, its influence on the whole scheduling algorithm gradually weakens, because the transmission power of each node cannot be greater than  $P_{\text{max}}$ . (Figure 4)

Next, the effects of different iterations on the signal and interference plus noise ratio of different links are analyzed to investigate the iteration number and convergence of the algorithm. It is assumed that  $100 \times 100 \text{ m}^2$  plane space is used as the test environment, and  $P_{\text{max}}=100$ . By randomly selecting three nodes in the plane and observing the influence of the number of iterations of the algorithm on its signal-to-interference plus noise ratio, it can be seen from Figure 5, 6 and 7 that as the number of iterations increases, the signal-to-interference plus noise ratio (SINR) of the node gradually converges to the beta value and remains stable. Therefore, the scheduling scheme proposed in this paper has certain stability, and can achieve the goal of maximizing network capacity through continuous iteration.

In this part, the algorithm designed in this paper is mainly compared with the algorithm proposed by T.Kesselheim and GuanHongPei. For the convenience of the following discussion, the above two comparison algorithms are called Kesselheim algorithm and Pei algorithm respectively, which are respectively a centralized scheduling algorithm with a high degree of approximation and a distributed scheduling algorithm.

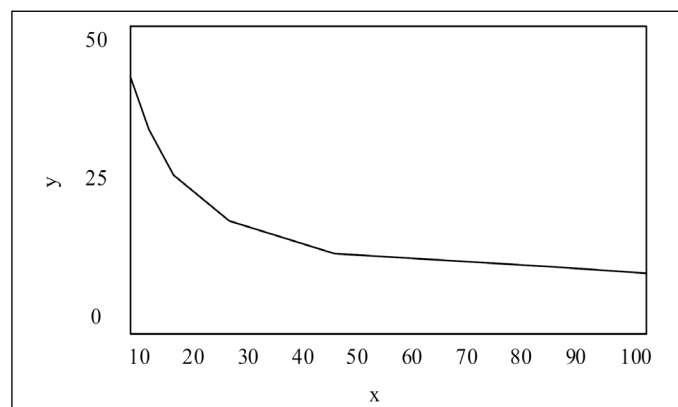


Figure 4. The Effect of  $\theta$  Value on Scheduling Results.

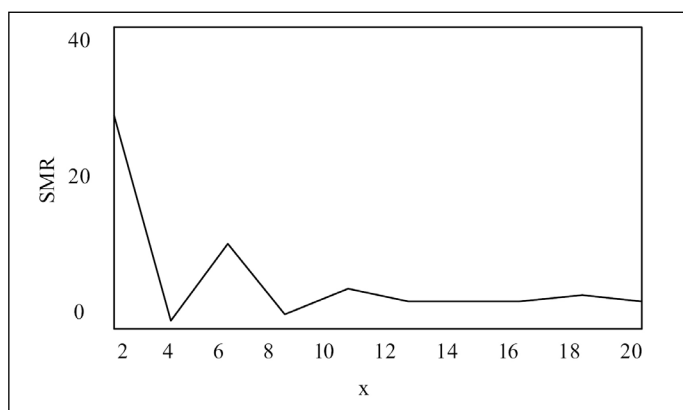


Figure 5. The relationship between the number of iterations and SINR (Node 1)..

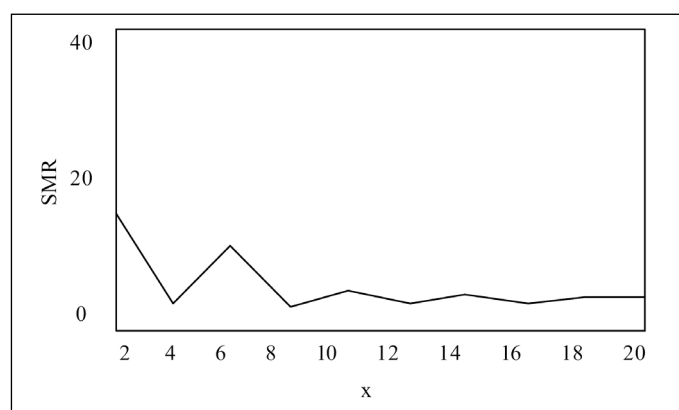


Figure 7. The relationship between the number of iterations and SINR (Node 3).

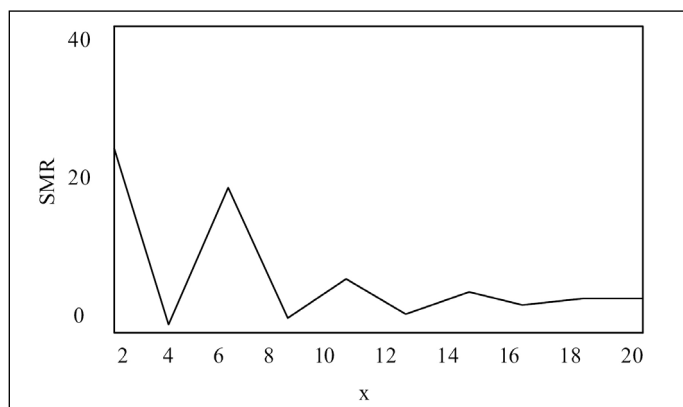


Figure 6. The relationship between the number of iterations and SINR (Node 2).

## CONCLUSION

In recent years, with the continuous development of IoT technology, people have put more experience into the research of its applications. For the athletes' biochemical indicator data during the training period, of which the changes are frequent and the collection efficiency is low, so the cloud technology is applied in this research to improve the work

efficiency. The problem of maximizing the network capacity of wireless sensor networks is transformed into an approximate equivalent problem by analyzing the pertinent properties of interference models, which is used as the condition for each sensor node in wireless sensor networks to judge whether it communicates or not based on the local information collected by itself. At the same time, by introducing the assumption of ideal interference model and utilizing its properties, a new distributed network scheduling scheme is obtained. After scheduling, the node determines its own transmission power according to the interference information it perceives. Finally, the feasibility of the scheme is proved by experimental analysis, and the efficiency of the above algorithm is analyzed and compared with the existing scheduling methods. This research effectively expands the application scope of cloud technology, and improves the efficiency of athletes' biochemical index processing during training period. However, there are still some shortcomings about this algorithm to be studied, and the next step is to combine theory with practice and to verify and improve the proposed algorithm by building a real network environment.

---

All authors declare no potential conflict of interest related to this article

---



---

**AUTHORS' CONTRIBUTIONS:** The author has completed the writing of the article or the critical review of its knowledge content. This paper can be used as the final draft of the manuscript. Every author has made an important contribution to this manuscript. Yang Weidong: writing and execution. Huang Huan: Data analysis.

---

## REFERENCES

1. Abawajy JH, Hassan MM. Federated Internet of Things and Cloud Computing Pervasive Patient Health Monitoring System. *IEEE Communications Magazine*. 2017;55(1):48-53.
2. Kecskemeti G, Casale G, Jha DN, Lyon J, Ranjan R. Modelling and simulation challenges in internet of things. *IEEE Cloud Computing*. 2017;4(1):62-9.
3. Bijarbooneh FH, Du W, Ngai EC, Fu X, Liu J. Cloud-assisted data fusion and sensor selection for internet of things. *IEEE Internet of Things Journal*. 2017;3(3):257-68.
4. Narman HS, Hossain MS, Atiqzaman M, Shen H. Scheduling internet of things applications in cloud computing. *Annals of Telecommunications*. 2017;72(1-2):79-93.
5. Linthicum DS. Connecting fog and cloud computing. *IEEE Cloud Computing*, 2017;4(2):18-20.
6. Ray PP, Mukherjee M, Shu L. Internet of Things for Disaster Management: State-of-the-Art and Prospects. *IEEE Access*. 2017;5(99):18818-35