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Research on Smart Fitness and Bodybuilding Based on Wireless Network Sensor Action Monitoring Device

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Abstract: *Fitness and bodybuilding has been developed in China for decades and is deeply loved by the masses. Under the background of the national fitness program and the general environment of the sports industry, China's fitness and bodybuilding has developed in the long-term in terms of scope and breadth, but the path model is single, and it is difficult to adapt to the development of the times. With the widespread popularity of 5G+IOT, wireless network sensor motion monitoring devices have been widely used in various fields of life, and the effect is very significant. This research focuses on the congestion control, energy efficiency optimization and node positioning of wireless sensor networks. Taking the physical distance between nodes as the starting point, the ID3 algorithm and the C4.5 algorithm are proposed in a targeted manner, and verified through theoretical analysis and software simulation effectiveness of the proposed algorithm.*

Keywords: *fitness and bodybuilding, wireless sensor network, ID3 algorithm, C4.5 algorithm*

1. Introduction

Fitness and bodybuilding has experienced decades of development in China, and it already has a certain sports influence. Fitness and bodybuilding has become more and more mature with the development of the times[1]. Wireless sensor networks have been widely used in the national economy and daily life, and are responsible for many functions such as data acquisition, state measurement, and equipment positioning. The wireless sensor network is composed of a large number of nodes connected by wireless ad hoc groups. Each node collects data independently and transmits the data to the central server according to the set routing protocol. According to the application characteristics of wireless sensor networks in different fields, a variety of routing protocols have been developed. These routing protocols have different performances in terms of node energy consumption, data delay, and congestion control. The location-based routing protocol is one of the more important ones. It mainly uses the location information of nodes in routing decisions, so it can effectively control the energy consumption of nodes and quickly respond to changes in network topology. Influenced by the international environment, the development of fitness and bodybuilding in China has become an inevitable trend. In countries with relatively advanced development of fitness and bodybuilding, fitness and bodybuilding events have become an important competition, communication and business platform for the sport. It plays an important role in all aspects of the development of fitness and bodybuilding. Also because of some niche features of fitness and bodybuilding, fitness and bodybuilding events have become inevitable for its sports development. Therefore, how to use the wireless network sensor motion monitoring device to play an important role in smart fitness has become the main research issue of this paper.

2. Related work

2.1 Fitness and bodybuilding

H B, An made an overall review of the development of bodybuilding in the past 30 years of my country's reform and opening up, and conducted research on the field of sports history in terms of bodybuilding competition, government, and industry, and came up with the following prospects. The organization and coordination of bodybuilding will be developed in various aspects, the inflow of funds

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to the fitness industry will increase, the fitness and bodybuilding events will flourish, and the national bodybuilding team system will continue[2]. L M, Cheng conducted a study on the development of fitness and bodybuilding in my country under the new background of sports industry policies greater progress[3]. And gave the following development paths, including leading the public fitness and leisure through fitness and bodybuilding, further promoting the development of the training industry, further expanding the competition performance industry, helping the transformation and upgrading of fitness and bodybuilding products, and promoting the development of sports communication through technology. Based on previous research, China's fitness and bodybuilding has developed rapidly under the new background of industrial policies and national fitness. The penetration rate of the project has been greatly improved, and the related training industry, leisure industry, and product manufacturing industry have all developed to a certain extent. But in general, fitness and bodybuilding is still a niche sport, and there is a certain gap between mainstream sports such as football and basketball at different levels.

2.2 Wireless sensor network

Wireless sensor networks are widely used in all walks of life and undertake the function of directly perceiving the objective world. In some wireless sensor network applications, sensor node location information is very important for sensing data, such as military applications, wildfire monitoring, medical care, etc. Node location information and perception data are tightly coupled, and data without location information is meaningless[4]. For example, in the detection of sudden events, as long as the specific location of the event is known, the correct decision can be made based on the collected data. In wildfire monitoring, the data collected by sensor nodes must know the exact location so that the area and location coordinates of the wildfire can be determined in time. In the routing based on geographic location, the premise of routing decision is that the node knows the location of the neighbor node or the distance from the neighbor node, and selects the best route according to the location or distance information. The efficiency and energy consumption of routing depend on the accuracy of node coordinates and locations. The easiest way to determine the node location is to measure the node location when deploying a wireless sensor network. But this method is not suitable for the random deployment of the usual wireless sensor network. Equip the node with a satellite navigation module, and rely on satellite navigation to accurately locate the node coordinates. However, the satellite navigation module is expensive and consumes too much energy, so it is not suitable for use in micro-miniature and cheap sensor networks. Moreover, in harsh environments such as underground and indoors, satellite navigation signals cannot be received at all. Therefore, low-cost and high-precision wireless sensor network node location research is called a research hotspot in wireless sensor networks. The usual wireless sensor network positioning algorithm is to deploy a small number of accurate and powerful beacon nodes in the positioning area, and the signal transmission range of the beacon nodes covers the entire positioning area. The unknown node measures the signal index of the beacon node, and combines other geometric or probability algorithms to calculate the coordinates of the unknown node. The difference between the algorithms is that the measured indicators and the calculation algorithms are different, resulting in different positioning accuracy. The positioning algorithm also considers the uncertainty of wireless signal propagation and the influence of positioning environment interference on positioning accuracy.

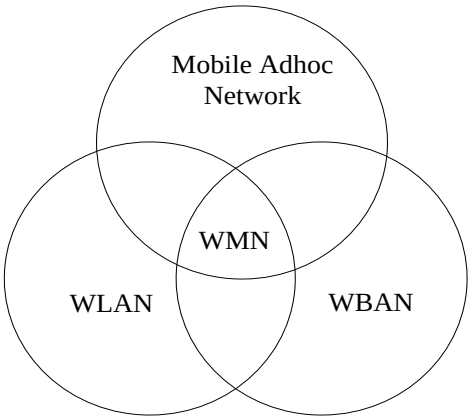

Figure 1. The relationship between wireless network sensor motion monitoring device and smart fitness

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3. Classical decision tree algorithm

3.1 ID3 algorithm

The ID3 algorithm is characterized by first calculating the information entropy of the attributes of the sample set, and selecting the optimal attributes for splitting by comparing these values. Use this attribute to divide the nodes to form a decision tree [5-6]. If the element included in member management Y is $\{x_1, x_2, \cdots, x_n\}$, and the occurrence probability of each element is $\{p_1, p_2, \cdots, p_n\}$ respectively, then the entropy of member management Y is defined as:

$$Info(Y) = -\sum_{i=1}^{n} p_i \log_2 p_i \tag{1}$$

The probability that an instance can be classified into category i is:

$$p(c_i) = \frac{c_i}{|Y|} \tag{2}$$

At this time, the entropy of member management Y is:

$$Info(Y) = -\sum_{i=1}^{n} p(c_i) \log_2 p(c_i) \tag{3}$$

If the attribute A is selected as the splitting attribute, the value is $\{a_1, a_2, \cdots, a_m\}$, and the data set is divided into m class through A, where the conditional information entropy is expressed as:

$$Info(Y|A) = -\sum_{i=1}^{n}\sum_{j=1}^{m} p(c_i, a_j) \log_2 p(c_i, a_j) \tag{4}$$

$$Info(Y|A) = -\sum_{j=1}^{m} p(a_j)\sum_{i=1}^{n} p(c_i|a_j) \log_2 p(c_i|a_j) \tag{5}$$

Then the information gain brought by attribute A is:

$$Gain(X, A) = Info(X) - Info(X|A) \tag{6}$$

When building a decision model through the ID3 algorithm, it is necessary to traverse each decision attribute and use the attribute with the largest information gain to divide the data set, so the decision tree obtained in this way is more accurate. The ID3 algorithm is shown in Figure 2.

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```
Algorithm:ID3
BuildID3(Y,T)
Input:
X:Training samples;
T:Root node, initially empty;
Output:
T:Decision tree root node
Begin
    Create node T with Y
    if Y all belong to the same class C
        return T
    end if
    if Y is empty or less than the given threshold
        return T
    end if
    Let n be the number of candidate attributes in node T
    for i=1:n
        Calculate Gain (Y, A) and find the attribute A that
maximizes the value
    end for
    Use A to divide Y into k subsets
    for i=1:k
        T.add(BuildID3(Yi,Ti))
    end for
End
```

Figure2. ID3 algorithm diagram

3.2 C4.5 algorithm

In order to calculate the efficiency of member management, the definition of its split information is as follows [7-8]:

$$Split(Y,A) = -\sum_{i=1}^{m} p(a_i)\log_2 p(a_i) \tag{7}$$

$$Split(Y,A) = -\sum_{i=1}^{m} \frac{n_i}{n}\log_2 \frac{n_i}{n} \tag{8}$$

Split information represents the information generated by dividing data set Y into subsets according to the value of decision attribute A, so there is a definition of membership management efficiency:

$$GainRatio(Y,A) = \frac{Gain(Y,A)}{Split(Y,A)} \tag{9}$$

3.3 Comparison and analysis of decision tree algorithms

Table 1.Comparison of typical decision tree algorithms

	Attribute Selection Metrics	Dealing with Continuous Attributes	Pruning Method	Do You Need an Independent Test Sample	Decision Tree Structure
ID3	Information Gain Rate	Discretization	Misclassification	Yes	Polytree
C4.5	Information Gain Rate	Pre-sort	Misclassification	No	Polytree
CART	CINI Coefficient	Pre-sort	MDL	No	Binary Tree

There are many decision tree algorithms. There are many differences in the scalability, execution speed, comprehensibility of the results, and accuracy of classification and prediction. A summary

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comparison of these algorithms is shown in Table 1.

4. Application of wireless network sensor action monitoring device in smart fitness and bodybuilding

4.1 Model realization

In order to complete the comparative experiment of the three decision tree schemes, and realize a fuzzy decision model, it has the functions of data importing, data fuzzification, generating decision tree model, model testing and instructions for use. The main business flowchart of the sports fitness membership management model is shown in Figure 3:

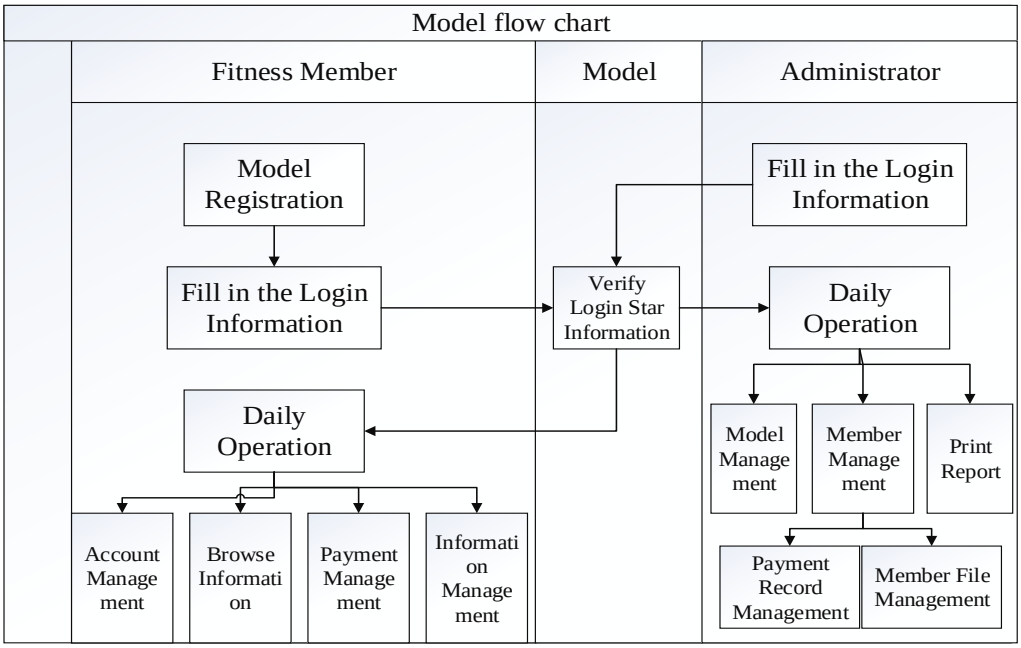

Figure 3. The main business flow chart of the sports fitness membership management model

4.2 Test subject

In order to obtain accurate and reliable experimental results to complete the analysis of the algorithm, we must first select the appropriate experimental data set. This article selects the 7 most commonly used data sets from the UCI data set as the initial experimental data to conduct model training on three different schemes. The specific description of the data set used is shown in Table 2. After training, apply the model to the analysis of customer churn, and then use the data of a certain club to conduct experiments. Customer data consists mainly of basic information, geographic distribution information and service information. Use statistical sampling to extract 1500 records from customer data in a given year. The characteristics of the customer in the database include: customer age, residential area, profitability, period of service, type of contract, etc. and customers are divided into YES (churn) and NO (no churn) Two types. Use these data files as training samples to create a vague decision tree for customer analysis and analyze the key factors of customer change.

Table 2. Data set introduction

S.no	Datasets	Instances	Number of Clesses(k)	Number of features(d)	Size of Class
1	Iris	150	3	4	50,50,50
2	Wine	178	3	13	59,74,48
3	Glass	214	5	9	29,76,70,17,22
4	Diabetes	768	2	8	268,500
5	Heartstatlog	270	2	13	150,120
6	Ionosphere	351	2	34	126,225
7	Sonar	208	2	60	97,111

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4.3 Experiment procedure

The experiment compared the three schemes. The first plan is to use the traditional decision tree ID3 algorithm to build a decision tree, the second plan is to use the fuzzy decision tree ID3 algorithm to build a decision tree, and the third plan is to build a decision tree based on the fuzzy decision tree ID3 algorithm of mobile computing. Figure 4 shows the decision tree established by the three schemes.

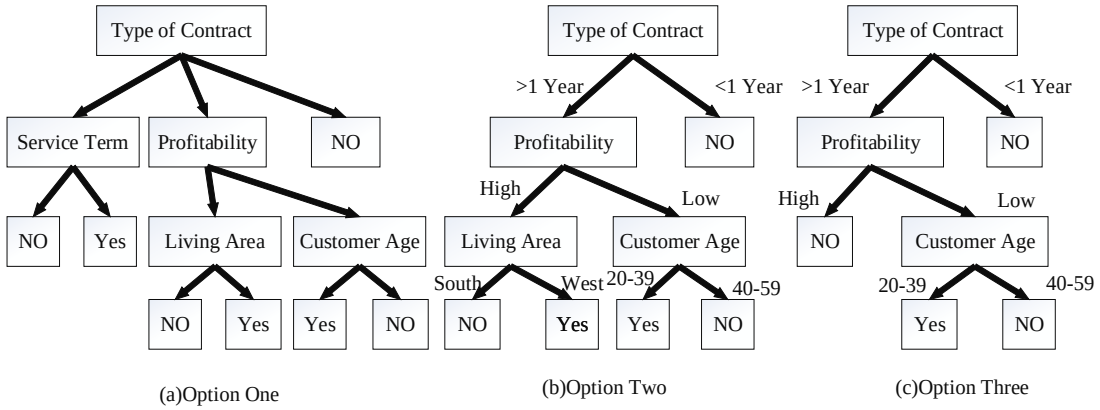

Figure 4. Decision tree built by three options

4.4 Statistical processing

Statistical analysis was performed with SPSS 13.0 statistical software. The significance test of the difference was performed by one-way analysis of variance, the difference between the two groups was tested by LSD-t, and the statistics of the results of the application of the fuzzy decision tree algorithm in the management of sports and fitness members were performed by the group t test. $P<0.05$ is considered to be significant and statistically significant.

5. Conclusion

As the upsurge of fitness sports in China continues to heat up, fitness sports have gained an unprecedented mass base. To a certain extent, it shows that Chinese residents' awareness of aesthetics and exercise has been significantly improved. There are still some differences between fitness and bodybuilding and the current fitness, but it is foreseeable that China's fitness and bodybuilding will usher in a faster development as a whole. Especially the dissemination of movement ideas and methods, It is even expected to become a mainstream form of sports in China in the near future. In recent years, artificial intelligence has developed rapidly in various fields, especially in pattern recognition and natural language processing. Reinforcement learning is one of the more popular machine learning algorithms. In the wireless sensor network environment, both routing decisions and node positioning can interact with the surrounding environment through reinforcement learning, take actions and obtain rewards, thereby strengthening their decision-making ability. In future research, combined with the results of this paper, the application of reinforcement learning and new artificial intelligence techniques in routing optimization and node positioning will be studied. Research the environmental adaptability of routing and positioning algorithms to achieve efficient use of energy, improve node positioning accuracy, and reduce decision-making delays.

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