Early Warning Method of College Students Mental Subhealth Based on Internet of Things

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Abstract. Aiming at the problem that the precision of information node localization is low, which leads to the low speed of information transmission. This paper puts forward an early-warning method of college students' mental sub-health based on Internet of Things. Using sensors to build the Internet of Things network in colleges and universities to complete the college students' mental health information collection and transmission. Association rule algorithm is used to analyze the original psychological information of students. Draw radar chart and evaluate the early warning grade of college students' mental health by radar chart comparison. Design the early warning information transmission plan according to the operation requirements of the IOT. At this point, based on the Internet of Things college students mental sub-health early warning method design completed. The experimental results show that this method can improve the accuracy of information node location and speed up the transmission of mental sub-health warning information.

Keywords: Internet of Things · Information Transmission · Mental Health · College Students · Early Warning Evaluation · Local Maintenance Mapping Algorithm

1 Introduction

Health is not only the foundation of people's lives, study and work, but also the guarantee of life quality. With the development of modern science and technology and the improvement of social civilization, people's understanding of health has changed from that of biology to that of sociology and psychology. This change in understanding, so that people's understanding of human health has undergone profound changes. Based on the formation of new ideas, it is also recognized that the standards of human health for most people are not met, but in a state of "sub-health" is not a disease. Scientific research has found that many diseases are related to psychological factors, such as coronary heart disease, hypertension, angina pectoris, etc., collectively referred to as psychosomatic diseases. Mental health is not only related to the success or failure of disease, career, but also closely related to people's survival [1, 2].

Mental sub-health, which exists in all occupations and all ages, has become a social and medical problem that can not be ignored. With the development of society and

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the popularization of networks, people's quality of life and life rate have improved accordingly. Everything is more haste, less reach, fast high-quality living environment easy to cause psychological burden, leading to the psychological sub-health of this new disease began to spread to college students in this group. From the demand of scientific research and practice promotion, college students as a professional group should pay attention to their overall risk structure. Further clarification of the distance and direction between the group risk structure and the idealized zero risk state and scientific early warning to provide quantitative support for action to reduce risk [3].

Reference [4] method studies the automatic detection and classification of cognitive distortions in mental health texts. A mental health dataset was collected based on a machine learning framework. Exploratory analyzes were performed using unsupervised content-based clustering and topic modeling algorithms. This method can detect the state of mental health to a certain extent, but the transmission rate of early warning information still needs to be improved. Reference [5] uses machine learning algorithms and deep neural networks to build electronic health record data models. A final risk score for each individual is calculated and calibrated. Individual-level analyzes of risk scores were performed to help healthcare providers managing risk cohorts interpret results. This method can detect abnormal mental health states to a certain extent. The intercommunication method in the transmission of information can be further improved.

The necessity of early warning stems from the severe situation of high incidence of group sub-health and the increasingly urgent requirement of mental health improvement. From the crisis management, scientific management, dissemination of energy efficiency, information support, scientific research, groups and individuals to effectively improve the existing needs. For modern universities, many universities use advanced information management system and operation system to make students study and live more convenient, fast and efficient. However, these activities are increasing in unprecedented depth and breadth, which creates an opportunity for us to analyze and understand the mental sub-health state of college students automatically and comprehensively. In the past studies, some college students' mental sub-health warning methods were also put forward, but the overall warning effect is not good. After comparing many kinds of technologies, we choose IOT technology to accomplish the early warning of college students' mental sub-health, and design the method based on IOT.

According to the application and development direction of Internet of things, the application architecture of Internet of things can be divided into three categories: WSN, RFID and machine-to-machine. The study used the Internet of Things to transmit the collected data to the gateway nodes. After all the data are collected at the gateway node, they are transmitted to Ethernet to provide treatment basis for teachers and counselors. These data can also be analyzed and processed through the analysis and processing warning mechanism of the host computer. If it goes beyond the normal scope, it will make a prompt, warning and other decision-making and control to promote the development of college students' mental health education.

2 Collection and Transmission of Information on College Students' Mental Subhealth

In this study, sensors were used to build the Internet of Things network in colleges and universities, and to perceive the psychological state of college students. In order to ensure the accuracy of the sending of early warning information, we first complete the positioning of college students with mental sub-health status. After comparing several methods, use the local preserving mapping algorithm to complete this partial processing.

In this study, the transfer time between nodes can be expressed as:

$$t = t_a + t_b + t_n \tag{1}$$

Among them, t_a is the time needed to transmit the signal between the receiving end and the transmitting node in the LOS environment. The ratio of t_b to error is small, which represents the system measurement error. It can be expressed as a Gaussian random variable subject to $N(0, \alpha)^2$ distribution. The ratio of t_n to error is very large, which represents the time error caused by non-line-of-sight radio propagation. It can be expressed as a random variable subject to an exponential distribution. Because the Internet of things used in colleges and universities are non-line-of-sight environment. Therefore, the statistics of the signal propagation time are expressed by the actual distance between nodes, and there are:

$$A\left[t_N^n\right] = nt_1^n d^n a^{\frac{n^2\delta}{2}} \tag{2}$$

where d represents the actual distance between nodes. t_1^n is the median of signal propagation time. n^2 represents the exponent of 0.5–1. δ is the calculated Gaussian random variable. Replace sample t_N^n with first order statistics. Then, the relationship between the signal arrival time and the distance between nodes in a sensor network can be expressed as:

$$t(g, g') = \frac{d(g, g')}{v} + t_1 d(g, g') a^{\frac{n^2}{2}} \tag{3}$$

$t(g, g')$ represents the signal transmission time between nodes. $d(g, g')$ represents the actual distance between nodes. v indicates the speed of the signal. The distance-based radial basis kernel function has the following form:

$$l(g, g') = f(d(g, g')) \tag{4}$$

$f(\cdot)$ represents the function defined in the target interval.

Since there are multiple nodes in the Internet of Things, the nodes have similarity. In the process of data collection and transmission, the process can be completed according to the similarity of nodes to improve the speed of information transmission. Therefore, the similarity between computable nodes provides convenience for the follow-up research, and the similarity between nodes can be calculated by the following Gaussian kernel function, specifically in the following form:

$$\begin{aligned} h(b_i, b_j) &= \exp(-o_G \left\| \eta(b_i) - \eta(b_j) \right\|^2) \\ &= \exp(-\sum_{i=1}^{n} o_G (t_{i1} - t_{j1})^2) \end{aligned} \tag{5}$$

o_G represents the adjustable function in the calculation. $\|\cdot\|$ stands for Euclidean norm. Through the above calculation process, the college students' psychological information is collected and transmitted. At the same time, according to this part of the content of the early warning information transmission process to control.

3 Design of Early Warning Methods for College Students' Mental Sub-Health

3.1 Information Analysis of College Students' Mental Subhealth

The collected psychological state information of college students is integrated into the designated database, and the original information is analyzed by association rule algorithm [6, 7]. Set $W = \{W1, W2, W3, ..., Wn\}$ as the information set or information set. Wi is a separate information, $R = \{R1, R2, R3, ..., Rn\}$ is a set of psychological features. Ri is a single psychological feature, and Ri is a subset of W.

In a rule $A' \Rightarrow B'$, A' and B' are mental feature sets. A' sets of psychological features represent the conditions under which rules are valid. The set of B' psychological features represents the result of the rule. The confidence level of the rule can be expressed by conditional probability $p(A'|B')$, based on the knowledge of probability theory:

$$confidence(A' \Rightarrow B') = p(A'|B') = \frac{p(A'B')}{p(A')} \tag{6}$$

According to this association rule, the following association rules are obtained. In a rule $A' \Rightarrow B'$, A' and B' are mental feature sets. The A' psychological feature set represents the condition of rule validity, and the B' psychological feature set represents the result of rule validity. The support of the rule can be expressed by probability $p(A'B')$, that is:

$$\sup port(A' \Rightarrow B') = p(A'B') \tag{7}$$

Through the fusion analysis of the above two laws, the promotion of the rules in application is obtained. The specific formula is as follows:

$$life(A' \Rightarrow B') = \frac{confidence(A' \Rightarrow B')}{\sup port(B')} = \frac{p(A'B')}{p(B')} \tag{8}$$

According to the above association rules, the confidence between the original information is calculated. The original information is preprocessed and analyzed, and it is drawn as a radar chart.

3.2 Early Warning Information Arrangement of College Students' Mental Subhealth

Based on the analysis of college students' mental sub-health state information, the radar map of college students' mental health is drawn, and the students' mental state is set as 8 dimensions. The 8-dimension offset vector is defined by the coordinate difference of eight index dimensions. Then:

$$P_i = P_{\alpha i} - P_{\beta i} \tag{9}$$

Here, P_i represents the offset of goal α from the i-dimension of goal β risk assignment. $P_{\alpha i}$ is the coordinates of the i-dimension of the target α (risk assignment). $P_{\beta i}$ is the coordinates of the i-metric dimension of goal β.

The coordinate definition of eight index dimensions of individual is clear, and the coordinate average value of each individual in group is used to define the coordinate coordinate of group radar chart. The overall risk drift is a ratio of the maximum area of two objectives. Namely:

$$S = \frac{W_c}{W_d} \tag{10}$$

Among them, S is the global offset of target c from target d risk assignment. W_c is the maximum area of the radar map for target c. W_d is the maximum area of the radar diagram for target d. From this formula, it can be seen that the overall deviation of an individual from the ideal zero risk is the risk assessment level corresponding to its own maximum risk radar area [8]. Namely:

$$S_i = H_i \tag{11}$$

Among them, the definition rule of H_i takes the concept of life model of radar area as the main content.

Using this formula, the total deviation is compared with the ideal zero risk value to obtain the arithmetic average of the maximum danger radar region for each person. For example:

$$S_j = H(E_i) \tag{12}$$

Among them, $E_i = \frac{(E_1+E_2+E_3+...+E_n)}{n}$. According to this formula, the early warning and evaluation grades of college students' mental health can be obtained, as shown in Table 1.

According to this form, the early warning information of the mental sub-health state of students can be obtained. And organize it into the form of information, and transmit and distribute it according to the design content of the first part of the text.

3.3 Design Early Warning Information Transmission Scheme

It is assumed that there are N wireless sensor nodes randomly and evenly distributed in an $M * N$ square area G. The set of nodes is represented as $\Im = \{\Im_1, \Im_2, \Im_3, ..., \Im_N\}$, which has the following properties:

(1) The network is a stationary network, and the sensor nodes and data aggregation points are both stationary nodes. That is, the positions are not moving after placement.

Table 1. Early warning and evaluation grade of college students' mental health

Level	Value result	Level content
I	0–0.5	Stablize
II	0.5–0.8	More stable
III	0.8–1.2	Convergence
IV	1.0–1.2	Warn
V	1.2–2.0	Alarm

(2) The sensor node knows its location. Nodes can rely on GPS, positioning algorithms and other auxiliary facilities or algorithms to obtain specific coordinates [4, 9].

According to the above two parts and the same energy attenuation model of LEACH protocol, the early-warning information transmission network model is constructed. The details are as follows:

$$\begin{aligned} Q_i(u,h) &= Q_1(u) + Q_2(u,h) \\ &= \begin{cases} uQ_1 + u\varpi_1 h^2, h < h_0 \\ uQ_1 + u\varpi_2 h^4, h \geq h_0 \end{cases} \end{aligned} \tag{13}$$

$$Q_{ei}(u,h) = Q_1(u) = uQ_1 \tag{14}$$

h represents the Euclidean distance between node i and node j. Q_1 represents the energy consumption of a circuit in receiving and transmitting radio waves. ϖ_1 and ϖ_2 represent the amplifier energy consumption of the free-space model and the multiplexed attenuation model, respectively. h_0 represents the constant in the calculation. u represents the number of bits a sensor node is sending and receiving data.

According to this network model, the sending cluster of early warning information is determined. When the first stage of cluster is established, the sensor node automatically generates a random number If $Z < \aleph$ ($\aleph$ indicates the threshold generated by the network), the node automatically becomes the cluster head. The size of the threshold is determined by the following formula:

$$\aleph = \begin{cases} \frac{k}{\left\{1 - b * \left[t \bmod \left(\frac{1}{b}\right)\right]\right\}} & j \in G' \\ 0 & else \end{cases} \tag{15}$$

Among them, b means the proportion of the selected cluster head in the whole network. t is the number of cycles in progress for the current network. G' represents a collection of all sensor nodes that have not been selected as cluster heads in the current network cycle. After the above calculation, the fusion analysis is made with the first part. The early warning information transmission scheme is drawn as shown in Fig. 1.

The information of mental sub-health state and the result of mental state evaluation were collected. According to the structure shown in Fig. 1, it transmits and warns the information in the form of early-warning information, and completes the process of early-warning. Organize the above settings. So far, based on the Internet of Things college students mental sub-health early warning method design completed.

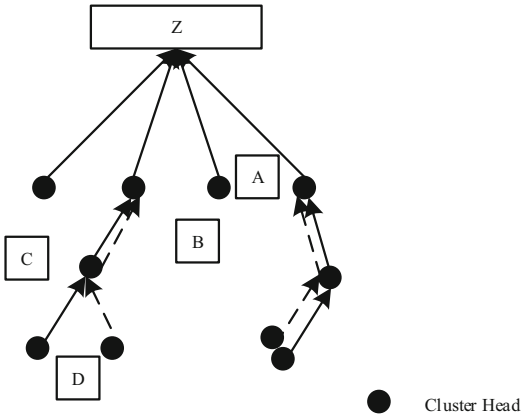


Fig. 1. Schematic Diagram of Early Warning Information Transmission for College Students' Mental Sub-Health

4 Experiment Analysis

In this study, an early-warning method of college students' mental sub-health based on the Internet of Things is proposed. In order to confirm the application value of this method, the experimental link was constructed to compare the application effect of this method with the current method.

4.1 Experimental Analysis on the Positioning Accuracy of Early Warning Nodes

In order to verify the proposed algorithm can improve the location accuracy of unknown nodes. We use MATLAB7.0 software to do simulation experiment. Factors such as positioning accuracy are commonly used in wireless sensor networks. In this paper, the accuracy of orientation, the accuracy of mental sub-health assessment and the transmission speed of early warning information are taken as the evaluation criteria. The distribution of alert information nodes in this experiment is shown in Fig. 2.

As shown in Fig. 2, in the simulation experiment, the area of college students' mental sub-health warning network is set to 50 * 50 m square area. In this region, 20 beacon nodes and 10–20 unknown nodes are distributed evenly and randomly. Suppose the calculated unknown node location is (x_2, y_2) and its real location is (x_1, y_1). Then the positioning error *Error* is:

$$Error = \frac{\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}}{n} \tag{16}$$

n represents the number of unknown nodes in the network. In this experiment, the method, basic method and artificial intelligence method are used to locate the receiving node of early warning information. The positioning accuracy of different methods is compared and the results are shown in Fig. 3.

Compared with the above experimental results, it can be seen that the positioning accuracy of early warning information node is relatively high. In the process of early

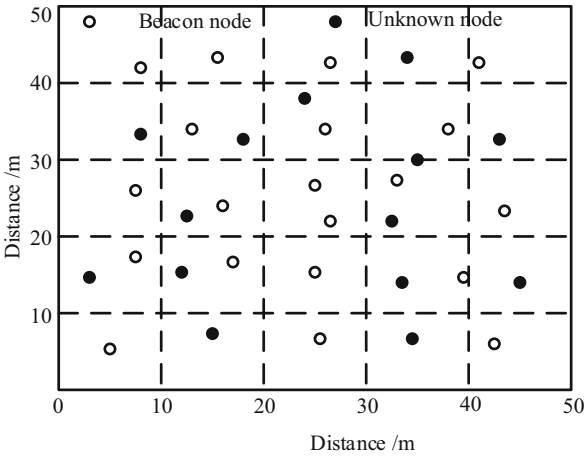


Fig. 2. Early warning network of mental sub-health state of college students

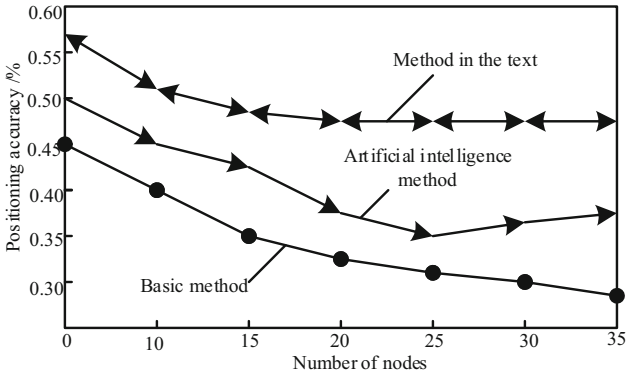


Fig. 3. Experiment results of early warning node positioning accuracy

warning information transmission, the transmission route of early warning information can be determined in the shortest time to improve the transmission speed of early warning information. Compared with the proposed method, the positioning accuracy of the basic method and the artificial intelligence method is relatively low. The results of this experiment may affect the transmission of early warning information. Therefore, the node location performance of these two methods needs to be optimized.

4.2 An Experimental Analysis on the Accuracy of Grades for Assessing Students' Mental Sub-Health State

In this experiment, 20 college students were selected as the experimental subjects, and experts in related fields were invited to evaluate the psychological sub-health status of their students after obtaining this behavioral information. The specific results are shown in Table 2.

Table 2. Student's mental sub-health state assessment results

Student number	Mental health rating	Student number	Mental health rating
D01	I	D11	III
D02	II	D12	IV
D03	I	D13	II
D04	I	D14	V
D05	I	D15	I
D06	IV	D16	II
D07	V	D17	V
D08	III	D18	II
D09	I	D19	III
D10	II	D20	IV

Using the contents of Table 2 as the control group, the mental health ratings of the subjects were evaluated by the above methods and other two methods. The accuracy of mental sub-health assessment was determined by three methods. The experimental results are shown in Table 3.

Table 3. Experimental Results of the Accuracy of Mental Sub-health Assessment of Students (unit: %)

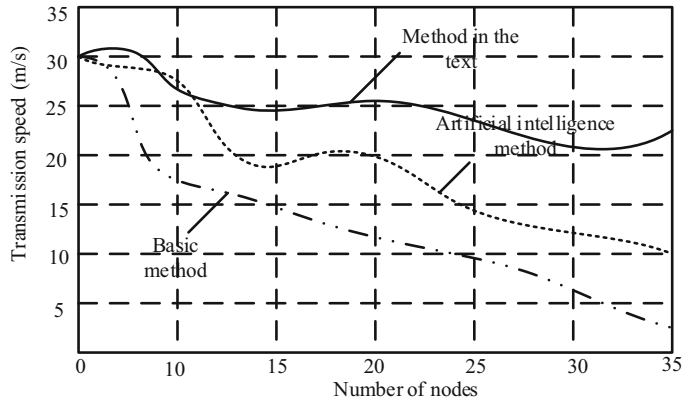
Student number	Method in the text	Basic method	Artificial intelligence approach	Student number	Method in the text	Basic method	Artificial intelligence approach
D01	95.86	93.24	94.49	D11	95.46	94.86	94.67
D02	96.72	93.25	94.85	D12	96.08	94.21	94.18
D03	95.68	94.48	94.61	D13	96.15	94.84	94.03
D04	96.16	94.75	94.56	D14	96.61	94.01	94.52
D05	96.66	94.75	94.81	D15	96.61	93.18	94.79
D06	95.09	94.69	94.26	D16	95.42	94.17	94.91
D07	96.57	94.35	94.14	D17	96.26	94.23	94.35
D08	96.69	94.81	94.96	D18	95.26	93.46	94.65
D09	95.77	94.7	94.33	D19	96.85	94.23	94.22
D10	96.49	94.04	94.36	D20	95.55	93.58	94.58

Through the analysis of the contents in Table 3, it can be seen that the mental sub-health status of the students in the method is more accurate. The evaluation results are more close to the expert evaluation results. Using this part of information can achieve

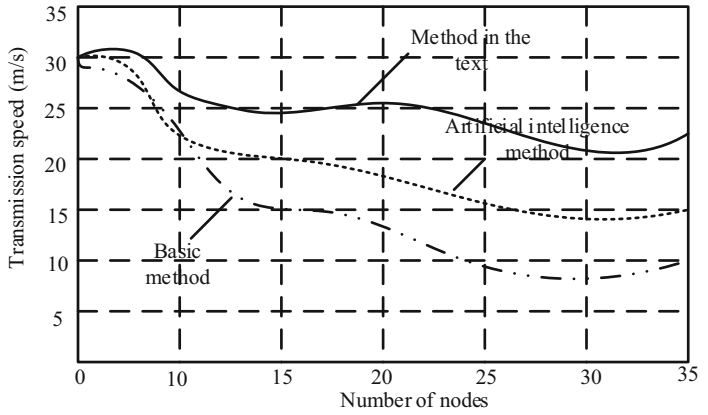
high precision early warning. Compared with the other two methods, the accuracy of mental sub-health assessment is relatively poor. In the process of early warning, some teachers and departments can not get the real warning information of students' mental sub-health and can not guide students in time. On the basis of collecting the mental health information of college students, the original psychological information is analyzed by using the association rule algorithm. The level of mental health warning of college students is evaluated by radar map, thus improving the accuracy of mental health warning.

4.3 Experimental Analysis on Transmission Speed of Early Warning Information

In order to ascertain the early warning information of mental sub-health state of college students, the information used in the experiment was sorted out. This part of the information is used to complete the experiment of early warning information transmission



(a) Contains unknown nodes



(b) Does not contain unknown nodes

Fig. 4. Experiment results of early warning information transmission speed

speed. During this experiment, we set the environment to contain unknown nodes and not unknown nodes. The result is shown in Fig. 4.

Analysis of the experimental results in Fig. 4 shows that when there are unknown nodes in the early- warning network, the transmission speed of early- warning information is different from other two methods. The data transmission speed of this method is better than other two methods. When there are no unknown nodes in the early- warning network, the difference of transmission speed of early-warning information between the proposed method and the other two methods is obviously reduced. Under the two experimental conditions, the transmission speed of early warning information is better than that of other two methods. Because this paper method uses sensors to build the information collected by the university Internet of Things network. According to the operation requirements of IOT, the early warning information transmission scheme is designed to improve the speed of information transmission.

5 Discussion

In order to establish the psychological early-warning mechanism, we should first establish the psychological early-warning information network and organize the existing resources in a certain way. Through this system, we can get the information about the psychological state of college students in time, process the information quickly, and respond effectively when necessary. In response to this requirement, in this study proposed based on the Internet of Things college students mental sub-health early warning methods. The main contents of this study are as follows:

(1) Because the source of students' psychological data is divided into several systems, the structure of the source database is analyzed, and a large number of data are sorted out and integrated. This makes it easier to do data mining analysis and makes it possible to analyze high-quality psychological information.
(2) This paper presents localization algorithm based on kernel local preserving mapping and localization algorithm based on gene expression programming. The feasibility of the two algorithms is analyzed, and the principle and steps of the two algorithms are introduced. The reliability of the algorithm is proved by MATLAB simulation.

On the basis of this study, the future research direction is prospected. As a systematic project, college students' mental health management has the characteristics of organic, dynamic and sustainable development. With the development of mental health management to a higher level, we should deepen the research of dynamic intelligent early warning system based on continuous monitoring time variable. The research and service objects should be shifted from focusing on college students to providing quality health management services for all citizens.

6 Conclusion

Aiming at the problems of poor accuracy and poor transmission speed in the early warning of college students' mental sub-health, this paper puts forward a method based on Internet of Things. In the future research, how to maintain the positioning accuracy

while reducing the amount of node positioning computation will be discussed. How to determine the optimal control parameters through the influence of genetic control parameters on the positioning accuracy is studied further.

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